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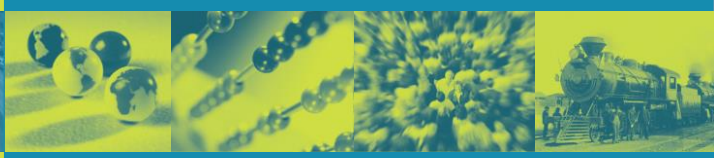

Individual uncertainty on longevity

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Abstract

The aim of this paper is to provide an assessment of individual uncertainty regarding length of life. We have collected original data through a survey performed in 2009 on a representative sample of 3,331 French people aged 18 or more. The survey design recorded several survival probabilities per individual, which makes it possible to compute (i) subjective life expectancy, defined as the first moment of the individual's subjective distribution of personal longevity; (ii) the standard error of this distribution, which provides insight on the individual's uncertainty regarding his or her own longevity. There is considerable between-individual variability in subjective life expectancies, in (small) part explained by age, illnesses, risky behavior, parents' death and socioeconomic variables. The second main finding is that individual subjective uncertainty about length of life is quite large, equal on average to more than 10 years for men and women. It is logically decreasing with age, but apart from age, very few variables are correlated with it. These results have important consequences for public health and retirement policy issues.

1 The importance of subjective life expectancies

For a long time, econometric analysis of choice data has been based on the assumption that decision makers have rational expectations, i.e., expectations that correspond to reality (Manski, 2004). It is of major importance to question this rational expectation assumption concerning survival probabilities. Indeed, more accurate information about individual beliefs regarding longevity might provide a better understanding of observed behaviors, in particular with decisions relative to retirement, pension plan choice, demand for long term care insurance, as well as prevention behavior and risky lifestyle. Another argument in favor of eliciting subjective life expectancies is that the information

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provided by life tables is rather limited, especially because they give little information about interindividual heterogeneity in life expectancy. They provide information about life expectancy by gender and age only, while personal health, parental longevity and lifestyle have an influence on the individual's life expectancy.

Many papers study survival expectations and subjective survival probabilities. Some of the data used in this literature result from direct questions on expected longevity (Hamermesh and Hamermesh 1983, Hamermesh 1985, Mirowsky 1999, Mirowsky and Ross 2000, Brouwer *et al.* 2005). Other studies rely on subjective survival probabilities as collected by the Health and Retirement Study (HRS), the Survey of Health, Ageing and Retirement in Europe (SHARE) or other surveys (Hurd and McGarry 1995, Liu, Tsou and Hammit 2007, Perozek 2008, Hurd 2009, Peracchi and Perotti 2011, Delavande & Rohwedder 2011, Kutlu-Koc and Kalwij 2013, Bissonnette and de Bresser 2013, Post and Hanewald 2013, Bago d'Uva *et al.* 2014). Many of these studies make use of cross sectional or longitudinal data to examine the relation between illnesses (or illness onset) and subjective survival probabilities. The results show that individuals make use of the available information in a rational way: illnesses have a negative impact on subjective survival probabilities; subjective survival probabilities are correlated with death rates observed afterwards in longitudinal data. Parental death appears to have an impact on subjective survival probabilities, especially for the parent of the same sex. In most papers, women report smaller survival probabilities than men despite their larger actuarial probabilities. Longitudinal data make it possible to see how probabilities are updated when there is new information (like the onset of an illness), and to examine the correlation between probabilities and corresponding outcomes observed in subsequent waves. Hurd (2009) and Delavande & Rohwedder (2011) show that expectations are well correlated with outcomes.

Most of the existing studies focus on average expectations by subgroup. There are few papers on the inter-individual dispersion of expectations (Post and Hanewald 2013), and, for lack of data, no study on subjective uncertainty at the individual level.[1] However, as argued in Edwards (2013), it is important to know how unsure people are about their longevity at the individual level because this is an important component of well-being alongside subjective life expectancy which is only an expected value. The survey results of Delprat et al. (2013) confirm that individuals are risk averse with respect to the longevity risk. This risk is also likely to be of major importance to understand, for instance, demand for annuities, prevention behavior, retirement decisions. For instance, Kalemli-Ozcan and Weil (2010) show that if subjective uncertainty about longevity is large enough, an increase in life expectancy may induce people to retire earlier rather than later because they may be sensitive to the increased probability of enjoying retirement.

Our purpose in this paper is to focus on this individual uncertainty on longevity. For this purpose, we have collected original data through a survey performed in 2009 on a representative sample of 3,331 French people aged 18 or more. We summarize our survey methodology in section 2 and describe the main features of our data in section 3. The survey design recorded individual subjective survival probabilities for every decadal age after current age and until the age of 90.[2] This enables us to compute, not only

[1] Post and Hanewald (2013) make an indirect estimation of subjective uncertainty on the basis of the relation between inter-individual heterogeneity in subjective survival probabilities and savings behavior. Socio-demographic subgroups with greater inter-individual heterogeneity in subjective survival probabilities should exhibit greater savings rates if this heterogeneity induced subjective uncertainty. Post and Hanewald do not observe this pattern and conclude that subjective uncertainty is low.

[2] This makes our data relatively rich compared to the data from HRS, which contain only two ques-

subjective life expectancy (SLE), but also individuals' subjective uncertainty regarding their longevity (SUL). SLE is defined as the first moment of each individual's subjective distribution of his or her own longevity. SUL is defined as the standard error of this distribution. In addition, the survey provided detailed information about objective health indicators (illnesses and disabilities), as well as a subjective indicator of self-assessed health (SAH). We find that there is considerable between-individual variability in SLE. Individual uncertainty relative to length of life (SUL) appears to be quite large, equal on average to more than 10 years for men and women. It is close to 15 years for people around 40 and still equal to 10 years for people around 55. To the best of our knowledge, it is the first time that direct empirical estimates of individual uncertainty regarding length of life are provided.

In section 4, we show the results of a regression model linking SAH, SLE and SUL to the individual characteristics of our respondents. The interindividual heterogeneity in SLE is partly explained by age, illnesses, risky behavior, parents' death and socioeconomic variables. The estimated impacts of illnesses and risky behaviors show that people are rational in adjusting their expectations to the available information. However, the bulk of SLE variability remains unexplained. This is even more the case for SUL. The individual uncertainty with respect to longevity is logically decreasing with age. Apart from age, very few observable variables have a significant effect. However, our estimates show that unobserved heterogeneity linked with more pessimism regarding length of life is connected with higher uncertainty.

In a nutshell, our main result is the extent of individual uncertainty regarding length of life. This huge individual uncertainty is observed together with a large between-individual variability of SLE, which appears to be realistic. Indeed, it is of the same magnitude as the between-individual variability of observed longevities that we can measure on an extinguished cohort. Section 5 concludes and discusses the economic relevancy of our findings.

2 Data

2.1 The survey

Our data come from an original survey that we performed in November and December 2009. The questionnaire was designed to elicit subjective survival probabilities as well as expectations regarding health and income. The data file is a cross section of 3,331 individuals aged 18 or more, representative of the corresponding French population, except that we secured an over-representation of people aged 50 and more.[3] Indeed, we needed enough observations of people affected by illnesses in order to draw relevant statistical inference as concerns the impact of illnesses on self assessed health and expectations regarding survival. All computations and estimations are weighted to obtain results that can be seen as representative of the French population. Our survey was performed face to face with a computer-assisted personal interviewing (CAPI) technique. Each interview took about 45 minutes. A preliminary pilot survey was performed on 30 respondents to remove possible ambiguities and improve the questionnaire wording.

tions on subjective survival probabilities, or from SHARE, where there is only one survival question.

[3]In comparison with the age structure of the population, we chose to double the proportion of people aged 50 or more in our sample.

The questionnaire first contains questions on age, gender and socioeconomic variables, such as education, individual and household income as well as insurance coverage. A lot of attention is devoted to health status, with detailed questions on specific illnesses, on self-assessed health, and on the individual's lifestyle (smoking, drinking, height and weight to compute a body mass index). The questionnaire then elicits subjective probabilities of survival at different ages and subjective joint distributions of income and health for future decades.[4] In addition, it allows for an evaluation of the individual's willingness-to-pay for being in perfect health, which makes it possible to calculate his/her equivalent income as a measure of well-being (Fleurbaey and Schokkaert, 2012; Fleurbaey and Blanchet, 2013, Fleurbaey *et al.*, 2013, Schokkaert *et al.*, 2014). Therefore, the survey provides rich information on individual trade-offs between income and health, as well as on individual expectations relative to three dimensions: income, health and longevity. The present paper focuses on subjective expectations relative to longevity**.** A companion paper (Luchini et al. 2014) studies subjective expectations about future income and future health, and the relation between subjective uncertainty about future health and subjective uncertainty about longevity.

2.2 Elicitation of subjective survival probabilities

Our strategy to elicit subjective survival probabilities follows Hurd and McGarry (1995) and Liu, Tsou and Hammitt (2007). Respondents are asked about their chance of being alive after a given age. For a respondent younger than 51, the first question is as follows:

"In your opinion, what is the percent chance that you will live beyond the age of 50?"

A scale is submitted to the respondent, with 14 values: 0%, 5%, 10%, 15%, 20%, 25%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%. Only one answer is allowed ("don't know" and "refusal" options are offered).

Once the respondent has answered the first subjective survival question, he or she is asked the same question again but for "more than 60", and then for the next decades up to "more than 90". As a result, respondents younger than 51 were asked five subjective survival questions, people between 51 and 60 were asked four survival questions and people between 81 and 90 one survival question only. In the survey design, follow-up questions are constrained: probability values strictly greater than the answer given to the previous question are not proposed. Therefore, subjective survival probabilities are weakly decreasing with age, by construction.

Our subjective life expectancy indicator (SLE) can only be computed for individuals who answered all survival questions. Removing all individuals who gave at least one protest answer ("don't know" or "refusal") to one of the survival questions, results in a final sample of 2,856 individuals. In the following, we check if our conclusions might be affected by a selection bias.

Let x_i denote the age at death of respondent i ($x_i = i$'s length of life). For a person under age 51, five probabilities are recorded:

$$\begin{array}{l} p_{50,i} = \Pr\left(x_i > 50\right),\ p_{60,i} = \Pr\left(x_i > 60\right),\ p_{70,i} = \Pr\left(x_i > 70\right), \\ p_{80,i} = \Pr\left(x_i > 80\right),\ p_{90,i} = \Pr\left(x_i > 90\right). \end{array} \tag{1}$$

For a person aged 75, for instance, only $p_{80,i}$ and $p_{90,i}$ are recorded.

[4] For instance, an individual aged 45 is asked about five future life decades: from 51 to 60 years old, 61 to 70, ..., 91 to 100.

We use the raw information provided by subjective probabilities to compute SLE for each respondent on the basis of three assumptions:

Assumption 1: All respondents will live up to 40: $P(x_i > 40) = 1$.

Assumption 2 : If the respondent is supposed to die in a given decade, he/she is supposed to die at the average age of death within the corresponding decade observed for people of the same sex in the population.[5]

Assumption 3: For the current decade, the death probability is uniform over the remaining years. For instance, a 53 year old respondent lives on average 3.5 years if he/she dies before 61.

Consider a male respondent i aged between 41 and 50. His SLE is computed as the expected value of x_i:

$$\begin{aligned} E_i(x_i) = P_i(40 < x_i \leq 50)b_i + P_i(50 < x_i \leq 60)56.01 \\ + P_i(60 < x_i \leq 70)65.92 + P_i(70 < x_i \leq 80)76.05 \\ + P_i(80 < x_i \leq 90)85.54 + P_i(x_i > 90)93.73, \end{aligned}$$

where $b_i = (50 - age_i)/2$ and

$$P_i(40 < x \leq 50) = 1 - p_{50,i};\ P_i(50 < x \leq 60) = p_{50,i} - p_{60,i};\ ... \tag{2}$$

Interestingly, having recorded several survival probabilities for the same individual enables us to compute the variance of this distribution, which provides insight in i's uncertainty about longevity. One has:

$$V_i(x_i) = \sum_j p_{j,i}(x^j - E_i(x_i))^2, \tag{3}$$

where $p_{j,i}$ is the subjective probability of death in decade j, and x^j is the age of death in this decade as given in Assumption 2. For the example considered above (a male between 41 and 50), this variance is given by:

$$\begin{aligned} V_i(x_i) = P_i(40 < x_i \leq 50)(b_i - E_i(x_i))^2 + P_i(50 < x_i \leq 60)(56.01 - E_i(x_i))^2 \\ + \ P_i(60 < x_i \leq 70)(65.92 - E_i(x_i))^2 + P_i(70 < x_i \leq 80)(76.05 - E_i(x_i))^2 \\ + \ P_i(80 < x_i \leq 90)(85.54 - E_i(x_i))^2 + P_i(90 < x_i \leq 100)(93.73 - E_i(x_i))^2. \end{aligned} \tag{4}$$

Hereafter, the corresponding standard deviation will be used as an indicator of the individual's uncertainty regarding his/her own longevity.

In summary, we define the two variables subjective life expectancy SLE and subjective uncertainty about longevity SUL as follows:

$$SLE_i = E_i(x_i);\quad SUL_i = \sqrt{V_i(x_i)}\ . \tag{5}$$

[5]This is more accurate than a linear interpolation, although it does not affect the main results. We used observed average age at death displayed by the French National Demography Institute for the year 2009. This gives for men dying within 41-50: 46.30 years; 51-60: 56.01 years; 61-70: 65.92 years; 71-80: 76.05 years; 81-90: 85.54 years; 91-100: 93.73 years. For women the corresponding figures are: 46.26 years, 55.94 years, 66.07 years, 76.35 years, 86.07 years and 94.22 years. We ignore survival beyond 100, therefore inducing a slight underestimation of subjective uncertainty.

2.3 Information about health

Our survey includes detailed questions on specific diseases that the respondent might have experienced in the previous 12 months. These are drawn from a list of 15 groups of questions (e.g. respiratory diseases, cardiovascular diseases, ...) taken from the *Enquête Santé et Protection Sociale* (Health and Social Protection Survey) of IRDES (Institute for Research and Information in Health Economics). On the whole, 45 illnesses are recorded. In addition, the respondent could add any other illness; the corresponding *verbatim* were recoded in ICD10 thanks to expert assessments by doctors. There are also questions on disability in the last 12 months measured by activity limitations, such as having difficulties to walk or in everyday activities, being bedridden, or suffering from pain.

At the end of that section came a question on self-assessed health (SAH_i):

"In the last questions, you have indicated your health problems over the last 12 months. With your answers in mind, please evaluate your level of health on the last 12 months with this scale from 0 to 100. 0 corresponds to death and 100 indicates the best possible health given your age."

Our survey thus provides a subjective measure of health and detailed objective indicators relative to illnesses and disabilities. Given the very large number of illnesses observed, we decided to classify them according to two criteria: whether they are chronic or not and whether they might threaten life in the short run or not. As a result, we obtain the following four categories:

- N: Illnesses that do not shorten or threaten life (for example: lumbago);
- A: Acute illnesses → immediate death risk (depression);
- C: Chronic condition → reduction in the length of life, but no immediate death risk (hypertension, diabetes);
- AC: Acute and chronic illnesses → immediate death risk and length of life reduced (asthma, myocardial infarction).

Hereafter, these categories are referred to as *vital risk variables*. The classification of the different illnesses (including the answers to open questions) in the four categories has been performed by a group of three doctors.[6]

Our motivation to create the vital risk categories stems from the goal to examine the link between illnesses, SAH and SLE. SAH is generally considered a good predictor of death risk. But the link between SAH and death risk might be more complex. As shown by Case and Paxson (2005), women have a worse SAH and more hospitalizations than men but lower death rates. Actually, the gender difference in SAH is mostly due to the types of conditions women face. These conditions are painful and deteriorate the quality of life (arthritis, lumbago, anxiety, etc.) but do not threaten life like heart diseases, for instance. More prevalent for men, heart diseases are not so painful, but have a larger impact on death rates.

[6] Their methods and results are described in Bahrami *et al.* (2011). The classification can be found in Table A.1.

3 Descriptive analysis

3.1 Basic features of the data

Descriptive statistics for our data are displayed in table 1. Means are computed for men and women separately, for all the explanatory variables used in our econometric specification. The sample is the one used for the estimation of a three-equation model, where all variables, including SAH, SLE and SUL, are observed for each individual. For each variable the p-value of the test for difference in average levels between men and women is given.

The socio-demographic characteristics confirm that the sample is representative of the French population as concerns education, income and coverage by health insurance (Schokkaert *et al.* 2014). There is a mandatory National Health Insurance in France that covers care only partially. To improve coverage, people can subscribe a complementary health insurance, mostly on a voluntary basis. Free complementary health insurance, named CMUC,[7] is provided to people who are very poor as the eligibility level of income for CMUC is much lower than the poverty level.[8] We observe in table 1 that a minority of respondents, 5 to 7%, are covered by the National Health Insurance only (i.e., do not have a complementary health insurance), which is close to the proportion observed for the whole French population. Similarly, the proportion of CMUC beneficiaries is in our sample close to the proportion observed in the whole population.

As stated above, we have summarized all the objective information relative to illnesses by vital risk variables, N (do not shorten or threaten life), A (acute), C (chronic) or AC (acute and chronic). Table 1 shows that women are more affected than men by illnesses of type N, that spoil life without shortening it: 53 % of them have 3 or more illnesses of type N, in contrast with 36 % of men. Women also have significantly more acute (type A) and acute and chronic (type AC) diseases than men. Otherwise, we do not observe any significant difference between men and women in the prevalence of chronic (C) diseases.[9] Figure A.1 in the appendix gives a more detailed picture of the prevalence by gender and age of vital risk categories. Turning now to functional limitations, all indicators in table 1 show that women are significantly more often affected by activity limitations and pain than men.

With respect to lifestyle, we find that women are more "virtuous": there is a significantly smaller proportion of smokers or drinkers among females than among males (see Table 1 and Figures A.2 and A.3).[10] On the other hand, the proportion of people who are obese, severely obese, or with normal weight is not significantly different between men and women (Table 1 and Figure A.4). A significant difference is observed for overweight, which is more frequent for men (34 %) than for women (22 %), and for underweight,

[7] *Couverture Maladie Universelle Complémentaire.*

[8] The income threshold for eligibility to CMUC is equal to 44% of median income.

[9] When looking in more details at illnesses that compose the different vital risk categories (see table A1 in the appendix), we observe that men and women are not affected by the same illnesses of type AC. Women have more asthma, whereas men have more heart diseases, which is in line with Case and Paxson (2005). On the contrary, there is generally no significant difference between men and women in the prevalence and composition of illnesses of type C (more precisely, if we focus on the most prevalent illnesses of type C, except for hypertension, women have as much cholesterol, bronchitis and diabetes as men).

[10] An individual is defined as "smoker" if he/she currently smokes. As concerns drinking, females belong to the "no risky behaviour" category if they take less than 14 drinks a week (females). The corresponding figure for males is 21 drinks a week.

which is rather rare altogether, but more frequent for women (5 % versus 1% for men).

The literature on subjective survival probabilities uses information on parental death as potential explanatory variable (Hurd and McGarry, 1995; Liu, Tsou and Hammitt, 2007). The figures displayed in Table 1 show that there is (unsurprisingly) no difference between men and women as regards parental death. Otherwise, it is noteworthy to observe that half of the respondents have lost their father, while two-thirds of them still have their mother. This gives a striking picture of the mortality differential between men and women. Our respondents are well aware of this mortality differential, at least as far as their parents are concerned.

3.2 Subjective survival probabilities

Figures 1 and 2 display our raw information for men and women, i.e., the distributions of subjective survival probabilities $p_{50,i}, ..., p_{90,i}$ defined by (1) and given by the respondents. Figure 1 shows the distribution of survival probabilities for all people younger than the target (e.g., the distribution of $p_{60,i}$ among people aged 60 and below), and figure 2 gives the probabilities for people less than ten years younger than the target age (e.g., the distribution of $p_{60,i}$ among people aged 51-60). These figures are rather similar for men and women. They show a wide dispersion of subjective survival probabilities. It is somewhat reduced when focusing on people close to the target age in figure 2, but not that much: it is still sizeable for any target. While there is a clear mode at $p_{j,i} = 1$ for younger target ages, the spread is large for target ages beyond 70. When people get older than 70, they have very different assessments about their survival chance. This large overall variability in the histograms can be due to (i) differences between individuals in terms of objective characteristics, including age; (ii) differences between individuals in their assessment of longevity (optimism or pessimism); (iii) individual uncertainty about personal longevity.

In a survey devoted to the use of subjective probabilities in research, Hurd (2009) emphasizes that many results suggest a response bias towards 50%. Indeed, the distributions in figure 2 for target ages equal to 80 and 90 show a mode at 0.5. If there is a bias of subjective probabilities towards 50 %, respondents understate the true probability when the latter is greater than 50 % and overstate the true probability when it is lower than 50 %. To examine the average bias, we have computed the differences $p_{j,i} - \overline{p}_{j,a(i)}$, $j = 50, ..., 90$, for each individual i, where $\overline{p}_{j,a(i)}$ is the survival proportion for men and women of the same age as i according to the life tables in 2009.[11] The resulting values of $\overline{p}_{50}$ to $\overline{p}_{80}$ are greater than 50 %, whatever the respondent's age or sex. The value of $\overline{p}_{90}$, i.e. the average probability to live beyond 90, is much lower. For men it is never greater than 50 %. More precisely, it increases from 18% for men under age 51 to 44 % for men aged more than 80. For women $\overline{p}_{90}$ is rising from 36 % for women under age 51 to 42 % for women whose age is between 71 and 80, and up to 56 % for women aged more than 80.

Figure 3 gives the average values of $p_{j,i} - \overline{p}_{j,a(i)}$ by age for men and women. In contrast with the histograms, Figure 3 does not show inter-individual variability, but gives an estimate of the average mistake for each probability $p_{50}, ..., p_{90}$. The sign of the average mistake of male respondents is consistent with Hurd's suggestion, with an understatement

[11] Notice that we have not adjusted the life tables to take into account the likely increase in longevity in the future. Respondents might be aware of this possibility. But we focus mostly on the individual variability in assessments rather than on their accuracy with respect to the "true" future longevity.

for p_{50} to p_{80} and an overstatement for p_{90}. Hurd's hypothesis does not hold for our female respondents, as they systematically underestimate their survival probabilities, even for $\overline{p}_{90} < 50\%$. Interestingly, the bias diminishes for all subjective probabilities when the respondent's age approaches the target (except for the male octogenarians who are increasingly optimistic with age).

3.3 Subjective life expectancy and subjective uncertainty about longevity

Figure 4 shows the distributions by age groups of the indicators SLE_i and SUL_i defined by (5). One observes a striking inter-individual variability SLE (red histograms), especially for people under age 61. This variability is smaller for older age groups who have to declare a smaller number of survival probabilities.

The variable SUL_i gives information on the level of uncertainty for *each individual* about his/her own longevity. We are mostly interested in the mean level of this variable. In comparison with the average level of SLE (between 75.7 and 90.5, depending on the age group), the mean of SUL appears to be very large, around 13 years for people under age 51, 10 years for people under age 61 and 7 years for people under age 71. Quite logically, uncertainty about longevity is decreasing with the respondent's age: when he/she is getting further on his/her survival curve, the range of possible values for longevity is indeed decreasing, leading to a decrease in the standard deviation.

Figure 5 displays the average SLE, as a function of respondent age, for men (blue continuous line) and women (red continuous line). The curves derive from nonparametric adjustments of a polynomial function of age.[12] They show that SLE is increasing with age, i.e. that individuals update their expectations when they survive to older ages.

The dotted lines on figure 5 give life expectancies (LE) provided by the life tables for year 2009 (French National Institute of Demography) and computed using the mortality rates observed in year 2009 for each generation. Since they are computed on the whole population, no variability affects these statistics and there is no confidence interval. As shown in figure 5, there is a large gender gap in LE computed from life tables for the whole population (dotted lines). Actually, France is one of the countries with the largest gender gap in LE at birth. It amounts to 6.7 in 2010, to be compared to 3.9 in the United Kingdom, 5 in the USA and 6 in Japan. This gap is due both to a rather high female LE at birth (84.8, at the third rank worldwide after Japan and Spain in 2010) and a rather low male LE at birth (78.1, at the 14th rank worldwide).

This gender gap is not reflected in SLE: figure 5 shows that male and female SLE are very close at every age. Actually, there is a slight and significant difference between women and men only when they are 40 to 55 years old. Another important feature of SLE is that males and females both underestimate their LE, in comparison with life table LE (dotted lines). The underestimation decreases with age. It is significantly different from 0 until the age of 70 for men and almost always significant for women.[13] It is much larger for females than for males, close to 10 years for women younger than 40. That women are more pessimistic than men is a result quoted in many papers studying subjective survival

[12] For the purpose of readability, we provide in figure 5 the confidence interval of the average SLE for men only.

[13] Notice that the underestimation is likely to be even more important than what appears on the figure: the official statistics are computed on the basis of mortality rates observed in one year and do not incorporate future progress.

probabilities (Hurd and McGarry, 1995; Liu, Tsou and Hammitt, 2007, Hurd, 2009). It is also found in Mirowsky (1999), who examines direct assessments of longevity.[14]

Figure 6 confirms the large interindividual variability of SLE : its standard deviation is equal to 10 years for people aged 35-40. It is slightly decreasing with age, but still equal to 6 years for people aged 60-65. One can wonder if this variability correctly reflects the true inequality in longevity between people. Actually, it is possible to measure the dispersion in longevity only on data relative to a "dead cohort", which can provide information on the age at death for all the individuals belonging to this cohort. Using data from the French National Institute of Demography, we have computed the standard deviation of ex post observed lengths of life for French people born in 1900. Figure 7 gives the between-individual standard deviation of longevity for people born in 1900 that have survived until the age given on the horizontal axis. The result is strikingly close to the curve obtained in figure 6, suggesting that the large between-individual variability in SLE reflects beliefs that are quite realistic.[15]

Figure 8 provides the mean of SUL_i by age. This indicator does not measure the same phenomenon as the between-individual variability of SLE_i shown in Figure 6. However, there is a link between the two concepts. Indeed, people might derive their subjective uncertainty from observing the variability in age at death among people around them. Conversely, the variability of SLE_i is partly influenced by SUL_i. The way individuals build their assessment of SLE_i is influenced by their education (potential knowledge of demography), their degree of pessimism, and their uncertainty about longevity (SUL_i).

SUL does not appear to be significantly different between men and women. As explained above, it is logically decreasing with age. The most noteworthy result is the magnitude of the average SUL: it is close to 15 years for young people (around 40) and still equal to 10 years for people around 55 (Figure 8). Remember that this indicator is a standard deviation for subjective longevity, with a corresponding first moment (SLE_i) equal to 77.5 for people between 51 and 60. This level of uncertainty seems considerable, and is likely to loom large when people have to make decisions on savings and retirement. Our direct estimates of SUL_i therefore offer a very different picture than the indirect approach of Post and Hanewald (2013).

Our econometric analysis will examine the determinants of SLE, SUL and self-assessed health (SAH). Figure 9 displays average SAH by age. As expected, it is continuously decreasing with age (the peak near 90 for men is due to a very small number of people and not significant). As in Case and Paxson (2005), women set their SAH at a lower level than men on average. This difference appears significant for women younger than 55.

Table 2 gives the means and standard deviations for SAH, SLE and SUL, as well as the p-values associated to the test for difference of the means between men and women. The same figures are given for the gap between SLE and life table life expectancies. This

[14]To check the robustness of our results, we used French data from SHARE, wave 2. The survival questions of SHARE are not the same as in our survey: only one survival question is asked, about the probability to live up to 75, 80, 85, 90 or 95, the unique target age depending on the respondent's age. As in our sample, we find that people strongly underestimate their survival probabilities and that there is no significant difference between men and women with respect to subjective survival probability. Detailed results are available on request.

[15]Note that "dead cohorts" can only be cohorts composed of individuals who experienced the first and second world wars —they might be special. However, we observe that the standard deviation in overall longevity does not change much over time: it is equal to 12.7 for people born in 1856 and who survived to at least 40, 13.7 for the 1886 cohort, 13.9 for the 1900 cohort and 13.6 for the 1910 cohort.

table summarizes the main conclusions of our descriptive analysis: SAH is significantly lower for women than for men; the average SLE is about 78-77 years, slightly higher for women; both men and women understate their life expectancy, with a much larger understatement for women; the standard deviation of SLE is quite large, indicating a large between-individual variability; the average SUL is very large, above 10 years, showing the magnitude of uncertainty in individual expectations of longevity; this uncertainty appears similar for men and women.

4 Econometric analysis

4.1 Empirical specification

We estimate separately for women and men a simultaneous-equation model explaining the individual's SAH, SLE and SUL:

$$\begin{array}{ll} \text{(I)} & SAH_i = \alpha_1' VR_i + \beta_2' X_{1,i} + \delta' Z_i + u_{1,i} \\ \text{(II)} & SLE_i = \gamma_2' SAH_i + \alpha_2' VR_i \ + \beta_2' X_{2,i} \ + u_{2,i} \\ \text{(III)} & SUL_i = \gamma_3' SAH_i \ + \alpha_3' VR_i \ + \ \beta_3' X_{2,i} + u_{3,i} \ , \end{array} \tag{6}$$

with $(u_{1,i} \quad u_{2,i} \ u_{3,i})' \sim (0, \Sigma)$ where Σ can be a non-diagonal matrix. The vectors $\alpha_1, \beta_1, \delta, \gamma_2, \alpha_2, \beta_2, \gamma_3, \alpha_3$ and β_3 are the parameters to be estimated.

The three dependent variables are explained by the set of vital risk variables VR_i ,i.e., dummy variables depicting the number of diseases of type N (do not shorten or threaten life), A (acute), C (chronic) or AC (acute and chronic). We did not include the detailed list of diseases in the regression since vital risk variables provide a more synthetic information. Indeed, diseases are not significant when they are included in the regression in addition to vital risks.

In equation (I), SAH_i is explained by vital risk variables, by $X_{1,i}$, which includes a quadratic function of age, socioeconomic variables (education, income and insurance coverage) and variables characterizing the individual's lifestyle, and by Z_i, the functional limitations experienced by the individual. SLE_i and SUL_i are explained by the subjective and objective indicators of health, SAH_i and VR_i, and by a set of regressors $X_{2,i}$ which contains the variables $X_{1,i}$ and information about the individual's parents (death and age of death). Following Hurd and McGarry (1995) and Liu, Tsou and Hammitt (2007), we suppose that individuals might use this information to assess their own longevity. We introduce for each parent four categories: alive, age of death ignored by the respondent, age of death greater or lower than the respondent's age. We supposed that information about parental death and age of death does not influence SAH and this is confirmed by preliminary regressions. Variables $X_{1,i}$, $X_{2,i}$, VR_i and Z_i are supposed to be exogenous, which is reasonable for health indicators, but more questionable for lifestyle variables.

We did not consider logarithmic transformations of the dependent variables. Indeed the distributions of SAH_i, SLE_i and SUL_i are rather close to normal distributions, according to the values of their skewness and kurtosis —at least closer than their logarithmic transformations.[16] The disturbances $u_{1,i} \quad u_{2,i}$ and $u_{3,i}$ are likely to capture unobserved heterogeneity that might explain SAH_i, SLE_i and SUL_i: individual's information about

[16] One has, for SAH_i, SLE_i and SUL_i respectively, skewness = –1.12, 0.7 and 0.14 ; kurtosis = 4.38, 3.2 and 2.37. When taking the log transformations the kurtosis is greater than 20 for $\log(SAH_i)$ and $\log(SUL_i)$ and their skewness is still negative and more distant from 0.

health (hereditary diseases) or lifestyle not recorded in the survey, heterogeneity in pessimism/optimism or in the personal weights given to vital risks and lifestyle, for instance, to form the subjective assessment of health and survival probabilities. Our specification allows for correlations between the three disturbances, i.e., for the possibility that unobserved determinants might be common to SAH_i, SLE_i and SUL_i.

Our simultaneous-equation model is recursive, at least regarding equations (I) and (II) as well as (I) and (III): SAH is an explanatory variable of SLE_i and SUL_i, while these two variables are not supposed to influence SAH. This structure is in line with the survey design, where questions about diseases and SAH are asked before survival probabilities. Moreover, it seemed rather unlikely to us that individual expectations regarding longevity influence SAH.[17] So, it appeared reasonable to adopt a recursive model with SAH explained first. This avoids the identification difficulties that would arise with a non-recursive model.

We have to deal with two econometric issues. Firstly, SAH_i can be non-exogenous in equations (II) and (III). To test for the exogeneity of SAH_i, we performed 3SLS estimations of equations (I),(II) and (III). Actually, our four indicators of functional limitations Z_i appear to be appropriate excluded instruments for SAH_i. Indeed, they are explanatory variables of SAH_i but have no direct influence on SLE_i and SUL_i — they are not significant when introduced in equations (II) and (III). Moreover, they are well correlated with SAH_i[18] and their exogeneity is not rejected by the Sargan test.[19] The results of first-step estimations and tests for men and women are detailed in the appendix, table A.2. With these instruments, the Hausman tests lead to non-rejection of SAH_i exogeneity for the SLE_i and SUL_i equations.[20] Notice also that the exogeneity of SAH in equations (II) and (III) is confirmed by a lack of correlation between the disturbances of equations (I) and (II) and of equations (I) and (III) (see bottom of table 3).

Secondly, about 15% of the respondents did not give all the survival probabilities requested to compute their SLE and SUL. Looking at their characteristics, we find that the individuals who did not give complete answers are slightly older and have a lower level of SAH. We used the Heckman two-step approach to deal with a possible selection bias. In the first step, we estimate the probability to participate separately for men and women, i.e., the probability to answer all the requested survival questions. Age, education and visits to a GP were included as explanatory variables for participation, as well as the information about parental death and a subjective level of happiness in some supplementary regressions. The inverse Mills ratios obtained from these first steps were never significant when included in equations (I), (II) and (III).[21]

[17] Of course, our cross-sectional dataset makes it impossible to draw conclusions about the direction of the causality between SAH and the subjective survival indicators.

[18] We check the weak instrument possibility by computing the Fisher statistics for the significance of Z_i in the first stage regressions. They are equal to 21.4 for women and 17 for men, respectively. Given that we use 4 instruments, we follow Bound *et al.*"s (1995) criteria and rule out a lack of correlation between them and SAH.

[19] The p-values for the Sargan statistic are respectively 0.21 and 0.22 for women and men.

[20] The p-values associated with the Hausman test statistics are, for the SLE equation, 0.783 for women and 0.165 for men; for the SUL equation, they are respectively equal to 0.08 for women and 0.06 for men. The p-value for the Hausman test for exogeneity of SAH in equation (III) being close to 5 %, we provide the 3SLS estimates in table A.3 in the appendix. As expected, they are very close to the GLS estimates. We prefer the latter because of their better precision.

[21] For example, with age, education and visits to a GP included as explanatory variables in the participation equation, the p-values associated to the inverse Mills ratio are, respectively for equations

We conclude from these investigations that a GLS estimator that allows for heteroskedasticity and correlations between the disturbances of equations (I), (II) and (III) can provide efficient estimates of our three-equation model 6.

4.2 Results

4.2.1 *SAH*

Columns 1 of table 3 presents the estimates of equation (I) for women and men. To appraise these estimates, the reader should keep in mind that average SAH is 72 for women and 76 for men on a 0-100 scale.

The impacts of vital risks appear to be significant and quite large. Some are valued similarly[22] by men and women: having 2 or more illnesses of type AC (Acute and Chronic, such as myocardial infarction or tumor) "costs" 7.3 points for women and 5.8 points for men; having at least one illness of type A (Acute, such as depression, phlebitis or pulmonary embolism) "costs" 8.6 points for women and 10.5 points for men. It is worth noticing that functional limitations have a significant negative influence on SAH (except being bed-ridden), even in a regression where vital risks are controlled for. Women and men evaluate the impact of functional limitations, i.e. disability and pain, similarly.

More differences appear between women and men for illnesses of type N (do not shorten or threaten life, such as migraine, lumbago or arthritis): having 1 or 2 of such illnesses decreases the assessment by women of their own health by 5.6 points, having 3 or more by 9.9 points. The corresponding values are significantly lower for men: 2.6 and 6 points. There is also a difference between women and men in the valuation of illnesses of type C (Chronic, such as hypertension or diabetes). In this case, men ascribe a higher cost than women do: having 1 illness of type C decreases SAH for men by 3.7 points, having 2 or more by 8.8 points. The corresponding values are much lower for women: 1.8 (not significant) and 5 points. These differences in assessments by men and women might derive from three factors: gender differences in the "pricing" of illnesses, unobserved differences in the seriousness of illnesses, or, more simply, differences in the prevalence of specific illnesses within the same vital risk category (within category AC, men have more heart attacks and women more asthma). Detailed regressions including illnesses instead of vital risk variables show that they are many differences between men and women in the impacts of illnesses on SAH. So, the three factors are likely to contribute to these gender differences.

The coefficients of the lifestyle variables show that women and men are aware of the deleterious impacts of smoking, overweight and obesity on health, and value the impact of these lifestyle variables on SAH identically. Men are a bit more aware about smoking: the estimated loss in SAH is 3.3 points for men and 2 points for women. Conversely, women ascribe greater losses in SAH for BMI problems. For alcohol, the only significant impact is a positive one: + 3 points for a non risky alcohol consumption by women (but not men). Women seem to have understood well the WHO advice relative to the admitted level of alcohol consumption.[23]

(I), (II) and (III), 0.578, 0.444 and 0.515 for women, and 0.430, 0.664 and 0.270 for men. More information can be obtained from the authors on request.

[22] In the whole of this section, the differences in coefficients between men and women that are commented on are significant (5 %).

[23] Note that causation in multiple directions is likely to occur for lifestyles and may provide alternative interpretations of these results. Respondents in bad health may smoke or fail to exercise because they

Finally, socio-economic variables indicating a low social position are correlated with a significantly lower SAH: having a diploma lower than the baccalauréat (high school graduation) for women (-3.8 to -5.9 points), an income below 875€ for men and women (-2.5 to -4.1 points) or being CMUC beneficiary for men (- 5.4 points).

4.2.2 SLE

Results concerning SLE (equation (II) of model 6) are presented in columns 2 of table 3. The average SLE is 78.8 years for women and 77.3 years for men with standard deviations equal to 9.7 for both women and men (see table 2). Individuals take SAH into account when determining their survival probabilities: SAH has a significant positive impact on SLE. A 10 point increase in SAH raises SLE by 0.8 year for women and 1.1 year for men.

In this equation, the estimated impacts of vital risks and lifestyle on SLE are direct effects that come on top of the indirect impacts via SAH in equation (I). For women, having one illness of type AC (Acute and Chronic) or at least one illness of type A (Acute) reduces SLE by 1.3 year. For men illnesses of type AC have no significant impact on SLE, whereas having at least one illness of type A shortens SLE by 2 years. Interestingly, both women and men ascribe a high loss in life expectancy to having 2 or more chronic illnesses (type C: hypertension, diabetes, etc.): they respectively associate a loss in SLE equal to 2.6 years and 1.9 year (which appear to be not significantly different). If we compute the total effect of having 2 or more chronic illnesses (direct effect + indirect effect through SAH) one finds a loss of 3 years for women and men. An interesting result is that illnesses of type N have no impact on SLE for men and women. Indeed, as mentioned before, the survey proposes a list of illness names, like lumbago, arthritis, diabetes, etc. The categorization in N, C, A or AC has not been communicated to the respondents, nor the information that a given illness does or does not shorten or threaten life. The fact that individuals do not adjust their survival probabilities (and, accordingly their SLE) with respect to illnesses of type N but expect a sizeable reduction for chronic diseases suggests that they are reasonably well informed regarding the impacts of illnesses on longevity.

A similar rational use of information is suggested by the estimated impacts of lifestyle. People are aware that smoking reduces life expectancy by 1.9 and 2.3 years, respectively, for women and men. Taking into account the indirect impact through SAH, one finds total reductions in SLE equal to 2.1 and 2.6 years respectively, for women and men. These effects may seem small in comparison to epidemiological results that exhibit a loss in LE equal to 6 years at 50 (and to 3 years at 60). However, in our multivariate analysis, part of the impact of smoking is captured by the impact of education level, income, BMI problems and drinking. Comparing the mean SLE directly between smokers and non smokers, we find significant differences of 5.7 and 5.8 years for men and women, i.e., losses in SLE that are consistent with the epidemiological results. Only men appear to be conscious of the influence of heavy drinking on longevity (2.3 year reduction in SLE), while men and women have well grasped the idea that a non risky alcohol consumption might be good for longevity (a gain of 1.1 to 1.2 years for women and men).[24] The results

are pessimistic about their longevity prospects. Women in bad health may drink less than women in good health because they do not feel well after drinking. Note, however, that these two alternative explanations are somewhat contradictory. If pessimism was the cause of unhealthy lifestyles, this should appear uniformly for smoking, excess weight and drinking.

[24] In France, where there are many wine producers, there is a lot of communication about this idea,

for BMI are striking. As we have seen, BMI problems lead to a much lower SAH - and have through this channel also a negative effect on SLE. On top of that indirect effect, however, individuals are not aware that a high BMI could directly shorten life. On the contrary, after controlling for SAH, obese women expect 1.7 more life years than other women. Although the sum of the direct and indirect effects remain negative, this result suggests that obesity for women has a larger effect on the perceived quality than on the perceived length of life.[25]

Some studies have shown that the longevity of same-sex parent has an influence of the individual's perceived survival probabilities (see for instance Liu *et al.,* 2007). We find a different result: only the longevity of the mother impacts individuals' SLE, especially if the age of the mother's death is unknown. In that case we estimate a decrease in SLE of 4.1 years for women and 3.8 years for men. The absence of impact of father's death might be linked to changes in habits between generations: men used to smoke in high proportions in the old generations and were not always imitated by their offspring. In this context, a son could think that the age of his father's death does not offer relevant information about his own longevity if he does not smoke himself.[26] To check this idea, we estimated the same model on a sample restricted to smokers (these people are likely to have the same attitudes towards tobacco as their parents). The results are provided in table 4. Our results show a stronger impact of the longevity of the mother, for both men and women. Moreover, they show that, for men, the longevity of the father reduces SLE significantly (at the 10% level) if the father died at a younger age than the respondent (-1.8 points). This result again can be interpreted as evidence for people's rationality in setting their longevity expectations. Indeed, it suggests that the use of information relative to parental death depends on parents' and children's behaviors.

Finally, the impacts of socioeconomic variables show that people with low education or low social position are correct in foreseeing a shorter life for themselves: women with income below 875 € have a reduction in SLE equal to -1.2 years; men that are CMUC beneficiaries have a reduction in SLE of - 4.1 years.

On the whole, our respondents have adjusted their survival probabilities in relation to their illnesses, lifestyle and social position. The resulting variations in SLE correspond to the known impacts on actual longevity measured by epidemiological studies. Our results show that people make the difference between illnesses that threaten life and illnesses that do not, and that they somehow internalize the connection between a lower social position and a shorter life. At the same time, however, it is worth noticing that the bulk of SLE variability remains unexplained: while the standard deviation of SLE is equal to 9.61 years for women, the residual of our estimation still shows a standard deviation equal to 7.95 years. The R^2 is equal to 32 %. Very similar figures are obtained for men.

4.2.3 SUL and residual correlations

Results concerning individual uncertainty on longevity are displayed in column 3 of table 3. We have seen that the magnitude of SUL is considerable: on average it is equal to about 10.5 years for men and women. In contrast with the results obtained for SAH and SLE, few variables impact SUL significantly. Age has a quite logical negative impact, for

together with the warning that heavy drinking is bad for health.

[25] Once again, endogeneity of lifestyle may also play a role —for instance if some of the less healthy women are more careful about their weight.

[26] We thank Alain Trannoy who suggested this interpretation.

reasons already discussed above.[27] Having diseases of type N increases uncertainty slightly for women, obesity decreases men's SUL by one year for obese and severely obese men. Having an income below 875 € decreases uncertainty for men (-1.3 year). Otherwise, it is worth noticing that risky behaviors have no influence on SUL.

The estimates of the correlation coefficients between the disturbances of model 6 are displayed at the bottom of table 3. As expected, $\rho_{1,2}$ and $\rho_{1,3}$ are not significantly different from zero, which confirms the exogeneity of SAH. It suggests that unobserved heterogeneity that contributes to the formation of SAH is not correlated with unobserved heterogeneity that influences survival probabilities and hence SLE and SUL. Statements about health seem to be quite separate from statements about longevity: there is no apparent connection between pessimism/optimism for SAH and SLE, or for SAH and SUL.[28] On the other hand, $\rho_{2,3}$ is significant and negative for women and men, suggesting that a lower SLE for given regressors, that we roughly interpret as pessimism for subjective life expectancy, is correlated with a higher individual uncertainty on longevity. This might result from the fact that longevity is naturally bounded —more uncertainty under a natural bound for longevity implies a lower expected value.

5 Conclusions

This study is based on original data collected through a survey performed in 2009 on a representative sample of 3,331 French people aged 18 or more. The survey design recorded several survival probabilities per individual, which makes it possible to compute an indicator of the individual's uncertainty regarding his or her own longevity (SUL) in addition to his/her subjective life expectancy (SLE).

Our analysis shows that women declare a lower self assessed health (SAH) than men, and that both men and women underestimate their life expectancy, with a much larger underestimation for women. The SLE values are characterized by a very large between-individual variability: for an average SLE equal to 78.8 years for women and 77.3 years for men, the standard deviation is equal to 9.7 for both women and men. This large between-individual variability of SLE seems consistent with the actual inequality in longevity between people, as it can be observed on a dead cohort. In other words, it reflects beliefs that are quite realistic. Individual uncertainty SUL is also very large: it is close to 15 years for people around 40 and still equal to 10 years for people around 55; on average it is larger than 10 years; the magnitude of this uncertainty appears to be similar for men and women.

Econometric estimations show that individuals are quite rational in adjusting their survival probabilities in relation to their illnesses, lifestyle and social position. The resulting variations in SLE correspond to the known impacts on actual longevity measured by epidemiological studies. Our results show that people know the deleterious impact of risky behavior on health and longevity; in addition, they show remarkable knowledge regarding the various impacts of illnesses on longevity: in particular, they make the difference between illnesses that threaten life or not. Moreover, individuals form their expectations on the basis of information that is consistent with the observed correlation between social position and longevity. Our main result is the magnitude of individual

[27] The strong impact of age is sufficient to give this equation a greater R^2, in spite of fewer significant coefficients.

[28] This refers to unobserved heterogeneity. Otherwise, individuals use information about their illnesses and SAH to evaluate their survival chances.

uncertainty about longevity. The degree of individual uncertainty is not well explained by observable personal characteristics of the respondents. The large uncertainty may reflect a rational assessment based on the observed variability in longevity between individuals: people might form their expectations observing the variability in age at death around them.

These results are relevant to issues of public health and retirement policies. Indeed, individual uncertainty about longevity affects prevention behavior, retirement decisions, pension plan choices, and demand for long-term care insurance.

Regarding prevention, people have a good knowledge about the fact that they can loose a few years of life, on average, if they smoke. In a pioneering paper, Hamermesh & Hamermesh (1983) also found that smokers are aware of the detrimental effects of smoking on longevity. They claimed that "the fact that smoking has not ceased entirely reflects people's willingness to take risks, not imperfect information about the effects of smoking." Interestingly, public health advice focuses on life expectancy, but it is not obvious that this is the relevant statistic for individuals concerned about their health and longevity. Our results show a large between-individual variability in SLE and a large SUL. What does this imply for individuals' perception of the health benefits of prevention and healthy behavior?

Consider a simple model of lifetime utility in which expected utility is equal to

$$U(c_1, s_1) + \sum_{t>1} p_t(s_1, ..., s_{t-1}) U(c_t, s_t),$$

where c_t and s_t are consumption and smoking in period t, and $p_t(\cdot)$ is the (unconditional) probability to be alive in period t (as a function of smoking in the previous periods). In this model, $SLE = 1 + \sum_{t>1} p_t$, and for a given SLE, maximum SUL obtains when p_t is constant over time (either one dies early or one enjoys the maximum lifespan). The relevant statistic for the evaluation of improvements in survival probabilities is generally not SLE, but $\sum_{t>1} p_t u_t$, where u_t is the utility enjoyed in t.

Interestingly, in such a context, endogeneity of consumption plans makes the assessment of prevention effects depend on current beliefs. With maximum uncertainty (constant p_t), the optimal consumption plan is quite flat, inducing a rather stable u_t over time, making SLE a reasonable proxy for $u_1 + \sum_{t>1} p_t u_t$. In contrast, with a declining p_t sequence, as in our data (SUL is large but far from maximal), the optimal consumption plan also displays a declining profile, inducing a declining u_t and making p_t less relevant for late periods of life. Such a situation may generate a mismatch between on the one hand public health messages centered on SLE and the improvement of old-age p_t, and on the other hand the strong focus of individuals on earlier risks.

Moreover, considering between-individual heterogeneity in SLE, this simple model also shows that pessimistic individuals (with low p_t for old age) are less likely to be sensitive to the possibility of raising SLE by increasing old-age p_t. This is consistent with the observation that the multiple characteristics of smokers reduce their SLE independently of the effect of smoking, therefore making them more pessimistic even before they smoke and justifying their relative willingness to take risks.

Let us now consider insurance decisions. Income insurance is attractive, but if people are not sure to live long, this uncertainty may justify their apparent myopia. Why save a lot if you may not live to enjoy it? Our results might shed light on the "annuity puzzle", raised by the lack of success of annuities in spite of the fact that they insure

individuals against the risk of outliving their savings (and, assuming they are actuarially fair, dominate ordinary bonds, at least under complete markets, as shown in Davidoff et al. 2005). As recalled in Beshears et al. (2013), the literature has found several possible explanations, such as adverse selection, bequest motives, uncertain healthcare expenses, and the presence of a default annuity embedded in Social Security and defined-benefit pension plans. Now, if individuals are strongly uncertain about their longevity, and if income support alleviates the danger of dire poverty after exhaustion of savings, the risk of dying early may loom larger than the risk of living too long. In this context, annuities increase the risk of not being able to take advantage of one's wealth, which may look particularly unappealing when people think that, in case of early health warnings, they would like to consume more than planned in the period in which they can still enjoy certain forms of expensive consumption (e.g., touristic trips).[29] Beshears et al.'s (2013) survey uncovers people's strong desire to remain in control of their wealth, which is completely consistent with their being anxious about an early death.

Decisions about retirement age may also be affected by uncertainty about longevity. As recalled in the introduction, Kalemli-Ozcan and Weil (2010) show that if SUL is sufficiently large, an increase in SLE may have the paradoxical effect of decreasing retirement age. This is due to the fact that the benefits of enjoying retirement loom larger (they have a greater probability) when longevity increases, thereby inducing people to plan an earlier retirement. In contrast, under low SUL, an increase in SLE simply induces a postponement of retirement plans (the probability of enjoying retirement is not affected, only its duration is at stake).

The political economy of pension policy is likely to be affected by a large SUL and a large between-individual dispersion in SLE. Raising the legal age of retirement when LE increases would seem acceptable, even logical, if everyone's expectations coincided with the average LE and if SUL was low. But if a sizable fraction of the population has a low SLE and/or a high SUL, raising the age of retirement reduces the probability of enjoying retirement for these people and may even go directly against their rational wish (per Kalemli-Ozcan and Weil) to retire earlier when SLE rises. Therefore, one should not be surprised at the public outrage triggered by pension policies that are based on average LE and ignore the dispersion and uncertainty affecting individual situations.

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[29] This is reinforced if the marginal utility of consumption goes down in very old age. Poverty in very old age is then seen ex ante as a lesser harm than failure to consume when marginal utility is still high.

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Figure 1: Distribution of subjective survival probabilities, men and women of all ages below the target

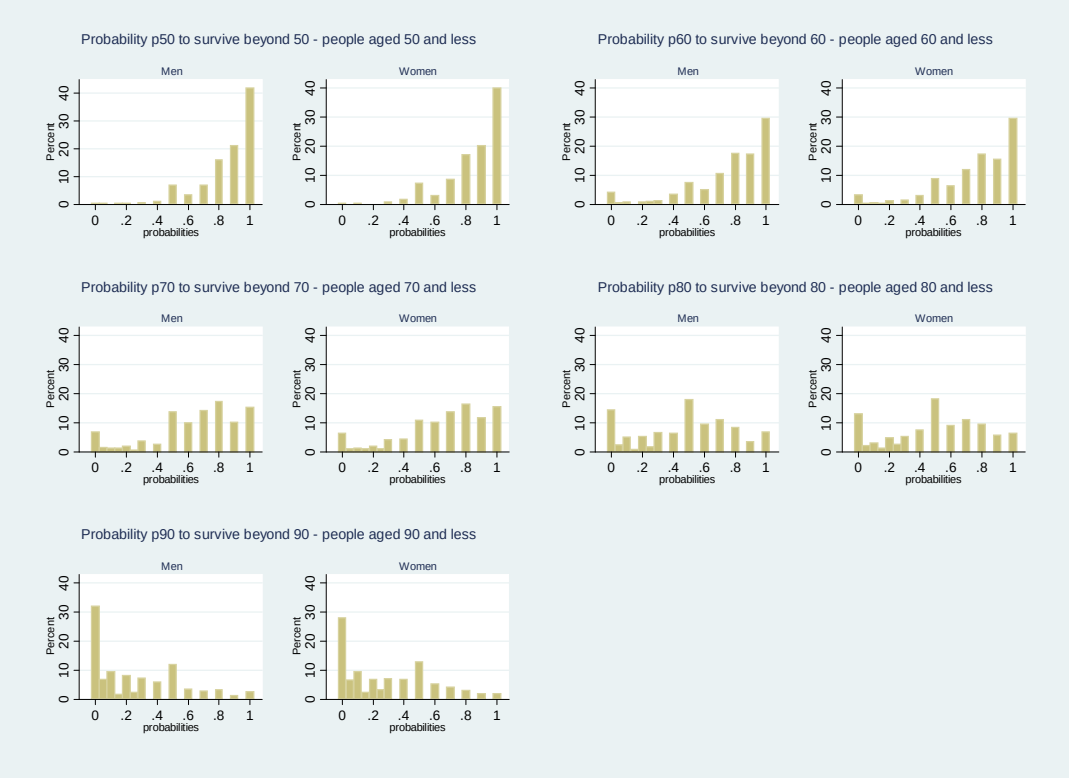

Figure 2: Distribution of subjective survival probabilities, men and women of ages close to the target (max 10 years)

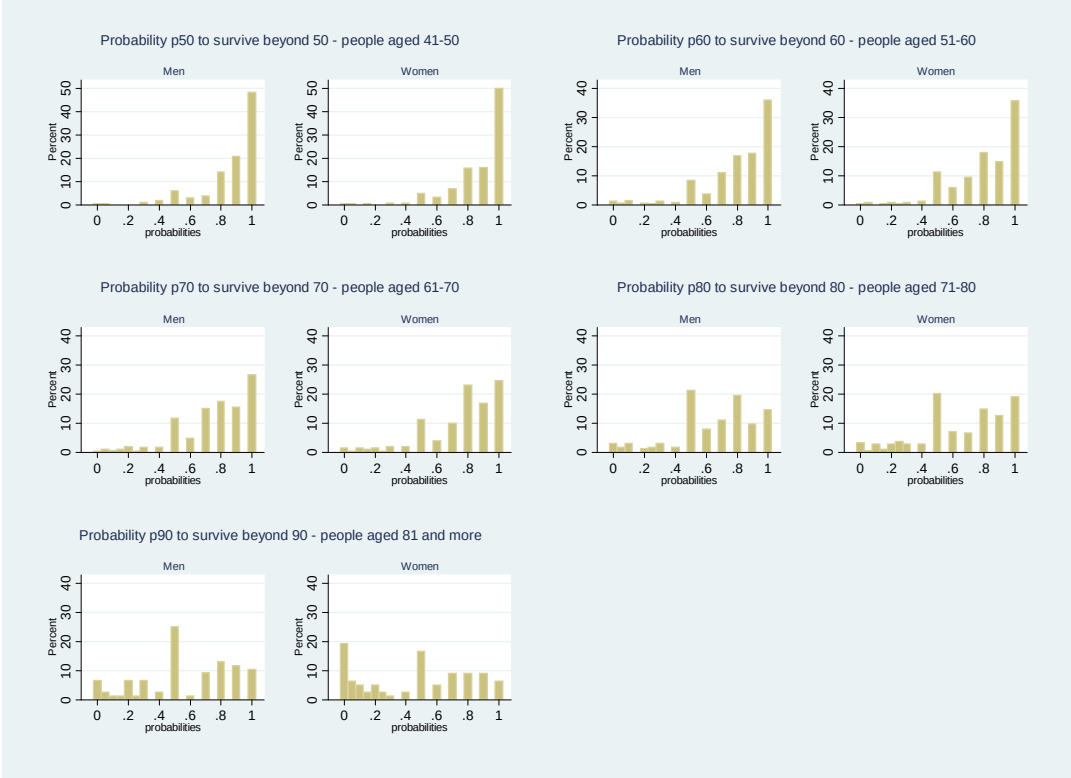

Figure 3: Average difference by age, between subjective survival probability and life table probability

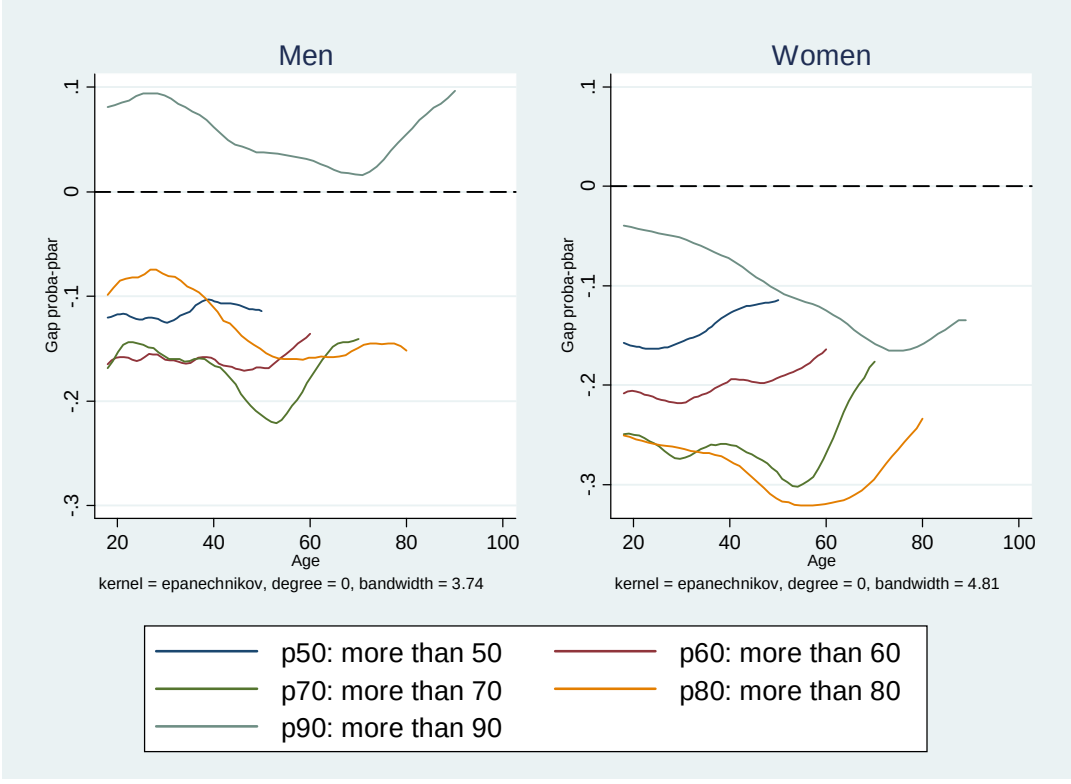

Figure 4: Distribution of SLE and SUL by age groups

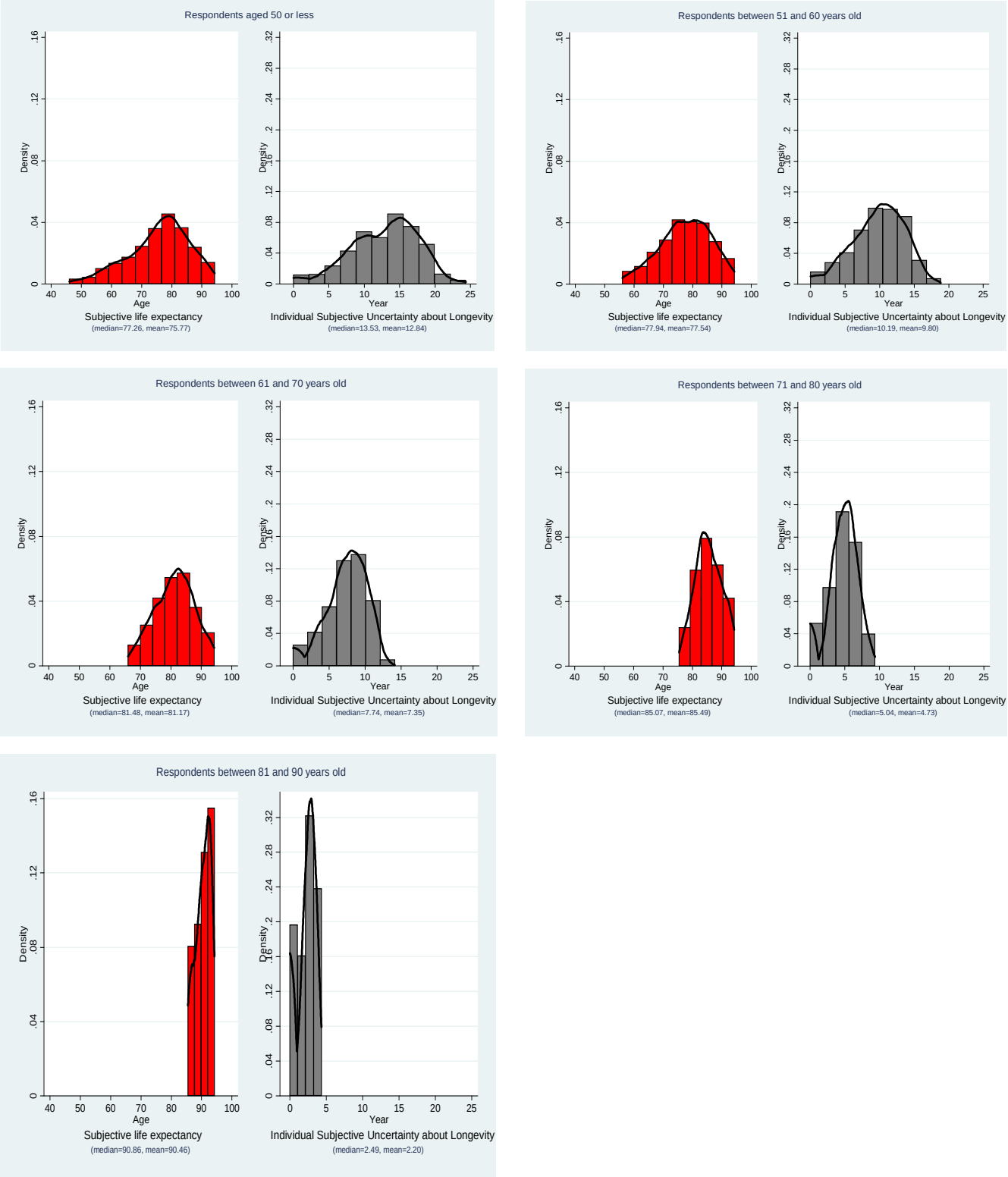

Figure 5: Average SLE and life table LE by age

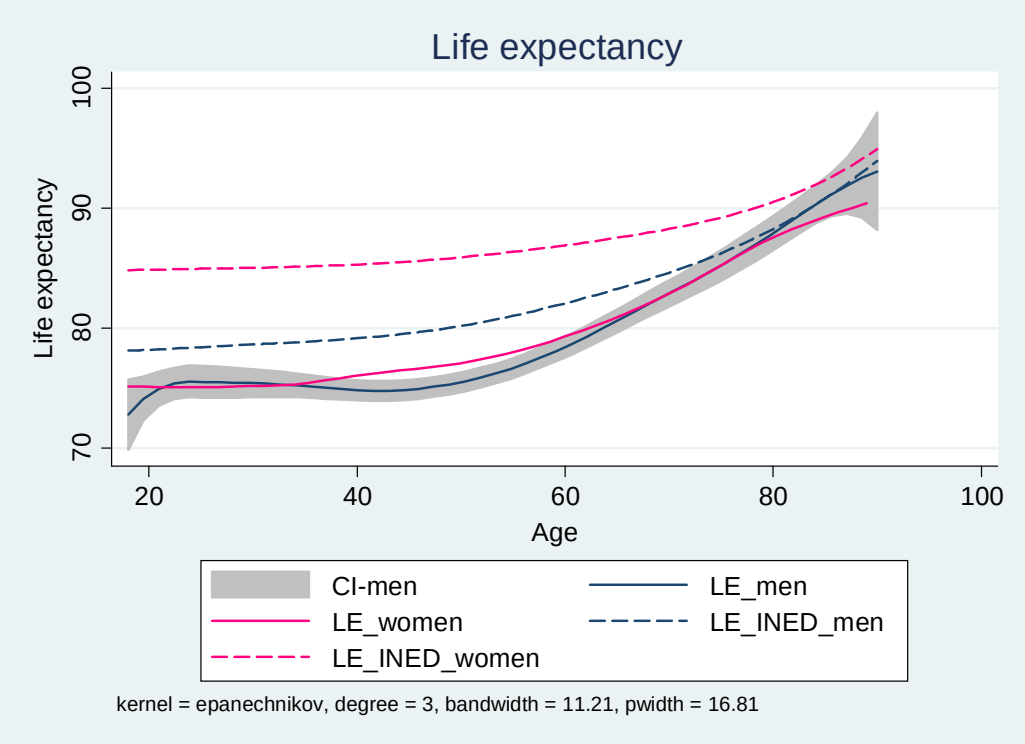

Figure 6: Between individuals variability in SLE (standard deviation by age groups)

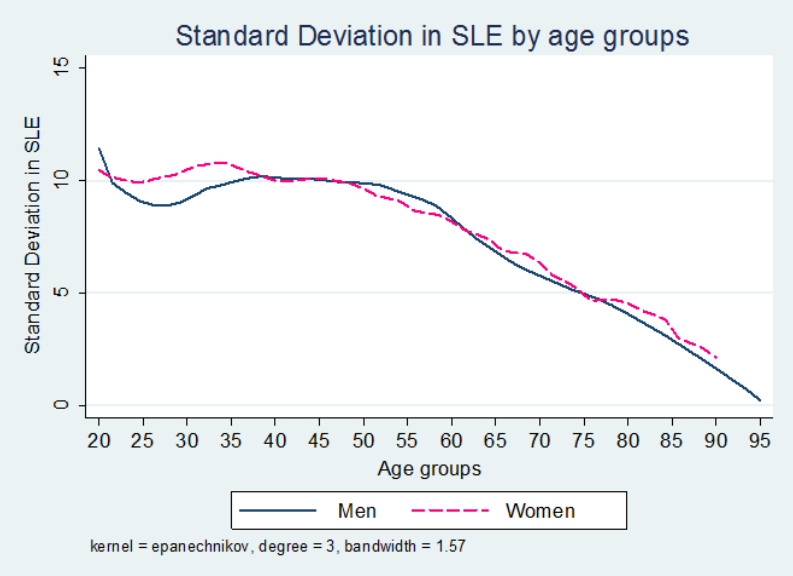

Figure 7: Standard deviation of individual longevity observed on a dead cohort

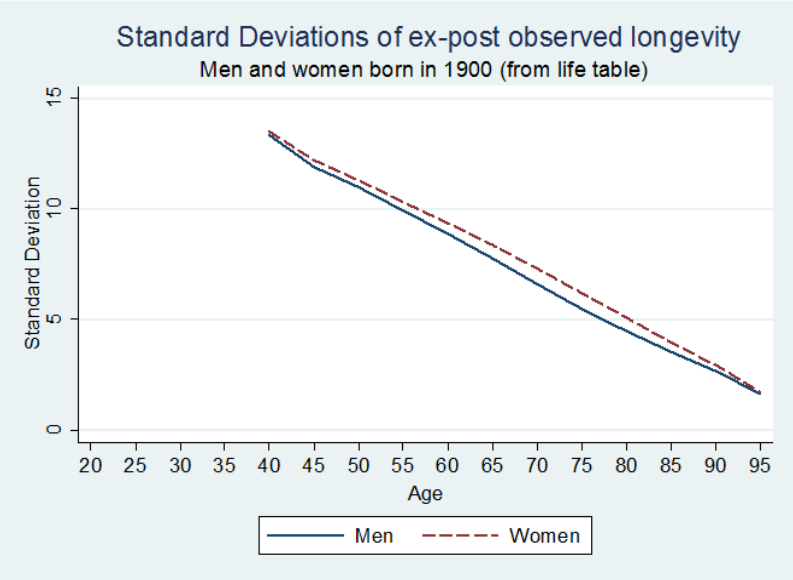

Figure 8: Average subjective uncertainty about longevity (SUL)

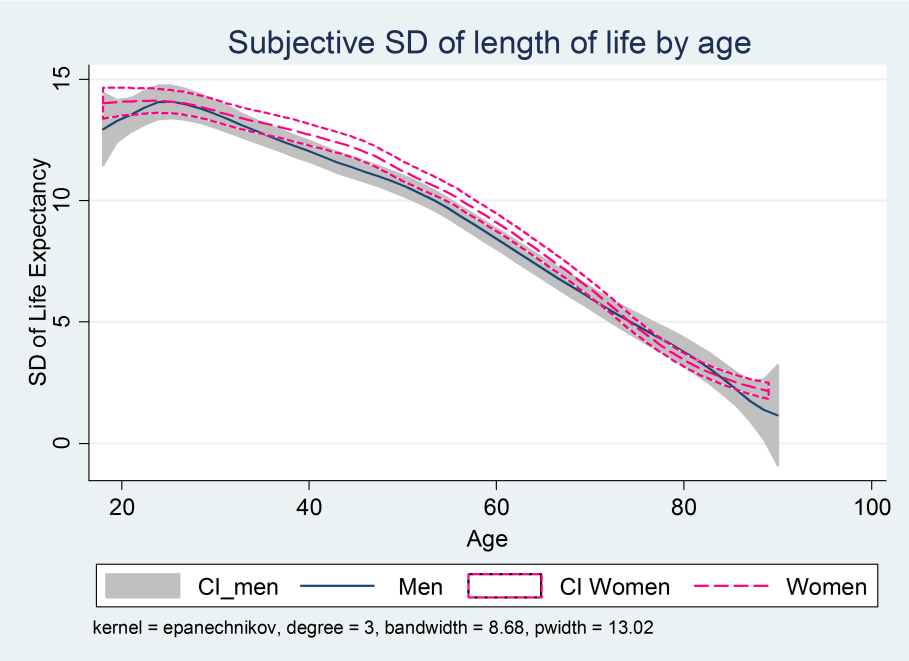

Figure 9: Average self assessed health (SAH)

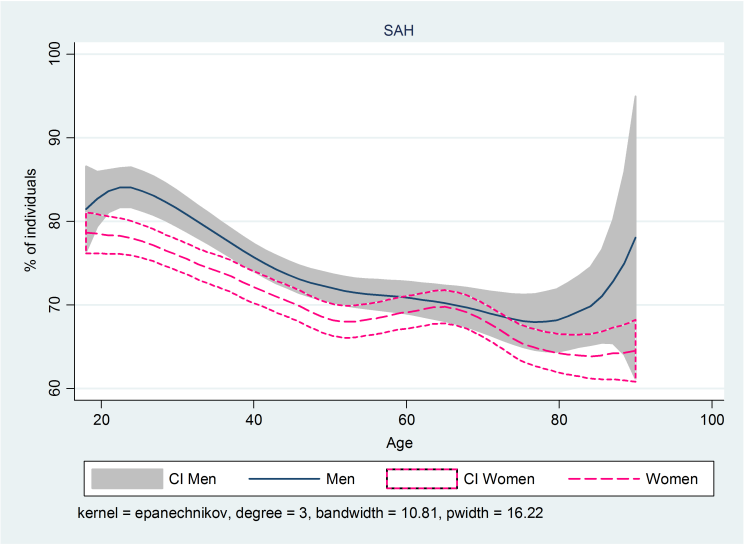

Table 1: Descriptive statistics

		Women	Men	p-value
Socio-demographic characteristics				
Age	Age	47.75 (18.56)	46.61 (17.62)	0.1156
Gender	Gender	0.52	0.48	0.0000
Education	No diploma	0.12	0.08	0.0018
	Primary School certificate	0.12	0.09	0.0027
	GCSE	0.34	0.40	0.0033
	Baccalauréat	0.16	0.17	0.7696
	University ≤ 2 years	0.13	0.11	0.0482
	University ≥ 3 years	0.13	0.16	0.0327
	Other diploma	0.001	0.002	0.4262
Income	Income ≤ 875 €	0.29	0.21	0.0000
	Income $\in [875 - 1290]$ €	0.26	0.23	0.1668
	Income $\in [1290 - 1800]$ €	0.24	0.27	0.0558
	Income > 1800 €	0.21	0.28	0.0000
Health Insurance	National Health Ins. only	0.05	0.07	0.0183
	Complementary Ins.	0.88	0.87	0.3228
	CMUC only	0.06	0.05	0.0454
Family Situation	Marital life	0.55	0.62	0.0002
	At least one child	0.45	0.35	0.0000
Health				
Vital Risks	0 illness of type N	0.14	0.22	0.0000
	1-2 illnesses of type N	0.33	0.42	0.0000
	≥ 3 illnesses of type N	0.53	0.36	0.0000
	0 illness of type AC	0.80	0.83	0.0334
	1 illness of type AC	0.16	0.13	0.0293
	≥ 2 illnesses of type AC	0.04	0.03	0.7942
	0 illness of type A	0.87	0.93	0.0000
	≥ 1 illnesses of type A	0.13	0.07	0.0000
	0 illness of type C	0.68	0.68	0.9345
	1 illness of type C	0.21	0.21	0.7283
	≥ 2 illnesses of type C	0.10	0.11	0.5204
Functional Limitations	Difficulties to walk	0.17	0.12	0.0001
	Bed-ridden	0.12	0.09	0.0026
	Difficulties in everyday activities	0.21	0.14	0.0000
	Pain	0.39	0.32	0.0008
Lifestyles	Smoker	0.32	0.40	0.0001
	Underweight	0.05	0.01	0.0000
	Normal weight	0.51	0.49	0.2392
	Overweight	0.22	0.34	0.0000
	Obese	0.11	0.09	0.2512
	Severely obese	0.07	0.06	0.2046
	No alcohol	0.34	0.19	0.0000
	Alcohol - no risk	0.63	0.75	0.0000
	Alcohol - risky behaviour	0.03	0.07	0.0000
Parent death and age of death	Father alive	0.48	0.48	0.9252
	Father deceased - age unknown	0.09	0.09	0.7963
	Father deceased - age $<$ than the ind.	0.31	0.32	0.3497
	Father deceased - age $>$ than the ind.	0.12	0.10	0.0480
	Mother alive	0.64	0.66	0.3611
	Mother deceased - age unknown	0.06	0.06	0.6598
	Mother deceased - age $<$ than the ind.	0.21	0.22	0.6878
	Mother deceased - age $>$ than the ind.	0.08	0.06	0.0028
Number of Observations		1,550	1,306	

Table 2: Summary statistics for SAH, SLE and SUL

	Women	Men	p-value
SAH	72.12	75.85	0.0000
	(21.15)	(18.63)	
SLE	78.79	77.32	0.0002
	(9.72)	(9.66)	
SUL	10.66	10.44	0.3158
	(5.48)	(5.04)	
SLE - Life tables LE	-7.65	-3.49	0.0000
	(9.07)	(8.87)	

Table 3: GLS estimation of the three-equation model, women and men

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
AGE						
Age	-0.447***	-0.293***	0.065*	-0.426***	-0.132	0.073*
	(0.152)	(0.071)	(0.037)	(0.153)	(0.081)	(0.040)
Age^2	0.004**	0.006***	-0.002***	0.003**	0.004***	-0.002***
	(0.002)	(0.001)	(0.000)	(0.002)	(0.001)	(0.000)
HEALTH						
SAH	-	0.084***	0.008	-	0.114***	-0.004
		(0.012)	(0.006)		(0.014)	(0.007)
Vital Risks:						
0 illness of type N	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1-2 illnesses of type N	-5.628***	-0.187	0.830**	-2.625**	-0.560	0.132
	(1.422)	(0.669)	(0.345)	(1.118)	(0.595)	(0.293)
$\geq$ 3 illnesses of type N	-9.934***	-0.857	0.754**	-5.999***	-1.067	0.184
	(1.427)	(0.667)	(0.344)	(1.245)	(0.649)	(0.320)
0 illness of type AC	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 illness of type AC	-6.926***	-1.348**	-0.074	-3.565***	-0.931	0.295
	(1.252)	(0.592)	(0.306)	(1.288)	(0.688)	(0.339)
$\geq$ 2 illnesses of type AC	-7.305***	1.312	-0.169	-5.783**	-1.509	0.327
	(2.591)	(1.213)	(0.626)	(2.389)	(1.276)	(0.629)
0 illness of type A	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
$\geq$ 1 illnesses of type A	-8.570***	-1.277*	-0.151	-10.522***	-2.019**	0.022
	(1.422)	(0.665)	(0.343)	(1.679)	(0.907)	(0.447)
0 illness of type C	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 illness of type C	-1.812	-0.881	0.270	-3.746***	-0.085	0.541*
	(1.183)	(0.555)	(0.287)	(1.132)	(0.606)	(0.299)
$\geq$ 2 illnesses of type C	-4.978***	-2.693***	-0.642	-8.802***	-1.957**	-0.436
	(1.703)	(0.798)	(0.412)	(1.564)	(0.845)	(0.416)
Functional Limitations:						
Difficulties to walk: Yes	-4.481***	-	-	-6.040***	-	-
	(1.372)			(1.434)		
Bed-ridden: Yes	-2.147	-	-	-1.423	-	-
	(1.538)			(1.616)		
Difficulties in everyday activities: Yes	-5.620***	-	-	-5.529***	-	-
	(1.523)			(1.585)		
Pain: Yes	-3.422***	-	-	-2.201**	-	-
	(1.204)			(1.103)		
PARENT DEATH AND AGE OF DEATH						

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Table 3 – continued from previous page

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
Father alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Father deceased - age unknown	0.887	0.341	0.525	-0.082	0.105	-0.061
	(2.211)	(1.036)	(0.535)	(1.983)	(1.060)	(0.522)
Father deceased - age < than the ind.	2.509**	-0.703	0.335	0.894	-0.946	-0.326
	(1.266)	(0.595)	(0.307)	(1.193)	(0.637)	(0.314)
Father deceased - age > than the ind.	0.162	0.063	0.415	-0.685	-1.243	0.011
	(1.929)	(0.905)	(0.467)	(1.908)	(1.016)	(0.501)
Mother alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Mother deceased - age unknown	-1.841	-4.060***	-0.270	-0.119	-3.782***	-0.675
	(2.720)	(1.274)	(0.657)	(2.379)	(1.271)	(0.627)
Mother deceased - age < than the ind.	-0.203	-3.176***	-0.111	-2.844	-1.997*	-0.225
	(2.168)	(1.015)	(0.524)	(2.221)	(1.188)	(0.586)
Mother deceased - age > than the ind.	-0.617	-2.498***	-0.337	-2.971**	-1.113	-0.427
	(1.404)	(0.657)	(0.339)	(1.317)	(0.704)	(0.347)
LIFESTYLES						
Smoker	-2.047*	-1.967***	-0.090	-3.344***	-2.250***	-0.419*
	(1.057)	(0.495)	(0.256)	(0.917)	(0.492)	(0.243)
Underweight	-1.116	-1.333	-0.389	-13.708***	4.399**	-1.621
	(2.088)	(0.980)	(0.506)	(3.977)	(2.132)	(1.051)
Normal weight	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Overweight	-2.777**	0.415	0.213	-1.540	-0.234	-0.036
	(1.117)	(0.524)	(0.271)	(0.973)	(0.520)	(0.257)
Obese	-3.270**	1.698**	0.394	-2.776*	0.071	-1.195***
	(1.510)	(0.707)	(0.365)	(1.530)	(0.818)	(0.403)
Severely obese	-10.393***	-0.134	0.146	-8.647***	-0.760	-1.171**
	(1.828)	(0.862)	(0.445)	(1.869)	(1.006)	(0.496)
No Alcohol	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Alcohol - no risk	3.051***	1.148**	-0.212	1.171	1.229**	0.037
	(0.976)	(0.458)	(0.236)	(1.100)	(0.588)	(0.290)
Alcohol - risky behaviour	-1.315	0.519	0.074	-0.735	-2.344**	0.044
	(2.834)	(1.328)	(0.686)	(1.903)	(1.017)	(0.502)
SOCIO-DEMOGRAPHIC						
Education:						
No diploma	-3.775**	-0.553	0.180	-3.058	-0.990	-0.450
	(1.811)	(0.850)	(0.439)	(1.866)	(0.996)	(0.491)
Primary School certificate	-5.896***	-0.368	0.475	-2.009	-1.794*	-0.307
	(1.872)	(0.878)	(0.453)	(1.917)	(1.025)	(0.505)
GCSE	-4.125***	-1.191*	0.978***	-0.897	-2.746***	-0.609*
	(1.365)	(0.642)	(0.331)	(1.244)	(0.664)	(0.328)
Baccalauréat	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
University ($\leq$ 2 years)	-0.675	0.933	1.097***	1.217	-1.710*	-0.660
	(1.639)	(0.769)	(0.397)	(1.640)	(0.875)	(0.431)
University ($\geq$ 3 years)	-2.796*	0.959	0.430	1.006	-0.480	0.141
	(1.681)	(0.789)	(0.407)	(1.511)	(0.805)	(0.397)
Other diploma	-30.429**	-3.409	0.689	-13.130	2.732	1.497
	(13.738)	(6.455)	(3.331)	(8.313)	(4.448)	(2.193)
Income:						
Income ≤ 875 €	-4.081***	-1.181*	-0.175	-2.507*	-0.653	-1.361***
	(1.383)	(0.651)	(0.336)	(1.313)	(0.702)	(0.346)
Income $\in [875 - 1290]$ €	-3.252**	-0.436	0.067	-0.720	-0.036	-0.592*
	(1.276)	(0.600)	(0.310)	(1.187)	(0.633)	(0.312)
Income $\in [1290 - 1800]$ €	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.

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Table 3 – continued from previous page

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
Income > 1800 €	-1.085	-0.051	-0.278	0.295	-1.198*	-0.490
	(1.346)	(0.631)	(0.326)	(1.165)	(0.623)	(0.307)
Health Insurance:						
National Health Ins. only	-1.091	-0.883	0.889*	-2.543	0.878	0.016
	(2.169)	(1.017)	(0.525)	(1.650)	(0.883)	(0.435)
CMUC only	2.285	-0.406	0.444	-5.373**	-4.076***	0.182
	(1.985)	(0.928)	(0.479)	(2.177)	(1.166)	(0.575)
Complementary Insurance	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Family Situation:						
Marital life	0.838	0.629	0.460*	1.362	-0.101	0.032
	(1.028)	(0.481)	(0.248)	(1.022)	(0.547)	(0.270)
Single	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
At least one child	0.402	-0.100	-0.179	1.170	-0.695	-0.121
	(1.050)	(0.493)	(0.254)	(1.069)	(0.571)	(0.281)
No Child	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Constant	102.780***	74.772***	12.019***	99.522***	69.001***	14.583***
	(3.674)	(2.112)	(1.090)	(3.499)	(2.346)	(1.157)
$\rho_{1,2}$		-0.002			0.010	
$\rho_{1,3}$		-0.012			-0.014	
$\rho_{2,3}$		-0.292***			-0.237***	
R2	0.352	0.316	0.440	0.357	0.333	0.402
St. Dev of Dependent Variable	21.04	9.61	5.48	18.45	9.69	5.05
RMSE	16.93	7.95	4.10	14.78	7.91	3.90
N		1504			1292	

Table 4: GLS estimation of the three equation model for smokers only, women and men

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
PARENT DEATH AND AGE OF DEATH						
Father alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Father deceased - age unknown	3.671	0.030	0.072	-0.266	-2.211	0.347
	(3.962)	(1.930)	(0.939)	(2.953)	(1.748)	(0.814)
Father deceased - age $<$ than the ind.	5.173**	-1.510	0.092	-0.366	-1.831*	0.045
	(2.235)	(1.093)	(0.532)	(1.840)	(1.080)	(0.503)
Father deceased - age $>$ than the ind.	-2.642	3.372	0.553	-3.117	-2.787	0.934
	(4.313)	(2.097)	(1.020)	(3.385)	(1.978)	(0.920)
Mother alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Mother deceased - age unknown	4.383	-5.692*	0.460	3.686	-5.483**	-0.998
	(6.201)	(3.010)	(1.465)	(4.094)	(2.425)	(1.128)
Mother deceased - age $<$ than the ind.	0.634	-5.618***	-1.462**	-2.029	-2.246*	-0.302
	(2.818)	(1.353)	(0.658)	(2.133)	(1.257)	(0.585)
Mother deceased - age $>$ than the ind.	-3.120	-6.912**	-0.686	-1.266	-4.805*	0.077
	(7.149)	(3.473)	(1.690)	(4.387)	(2.596)	(1.208)
All other variables from table 3 also included						
N		461			506	

7 Appendix

Figure A.1: Vital risk by age for men and women

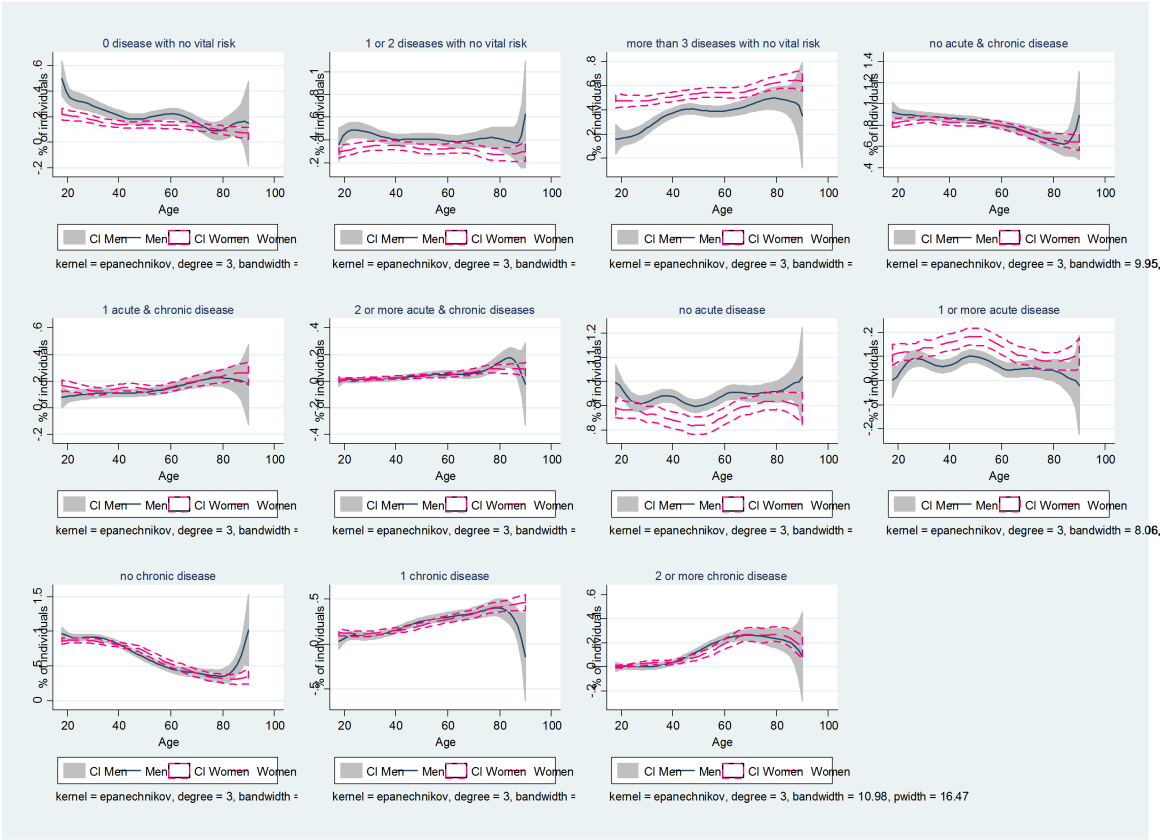

Figure A.2: Proportion of smokers by age and gender

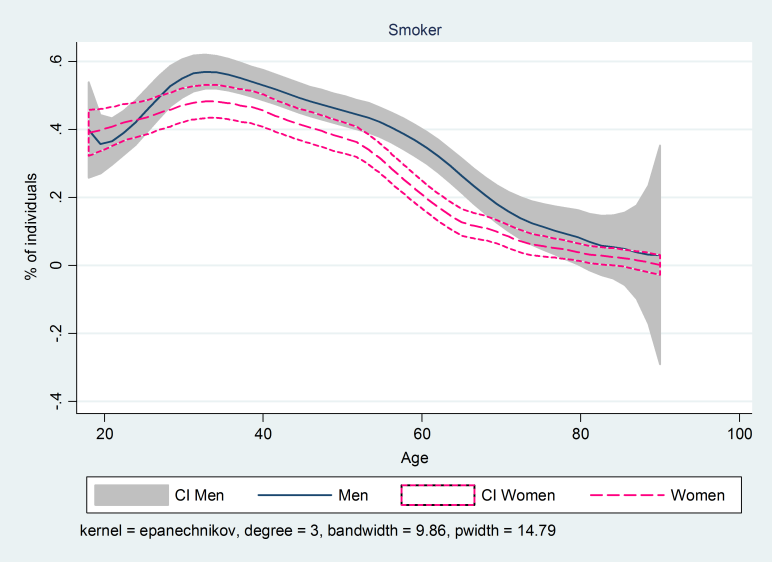

Figure A.3: Alcohol consumption by age for men and women

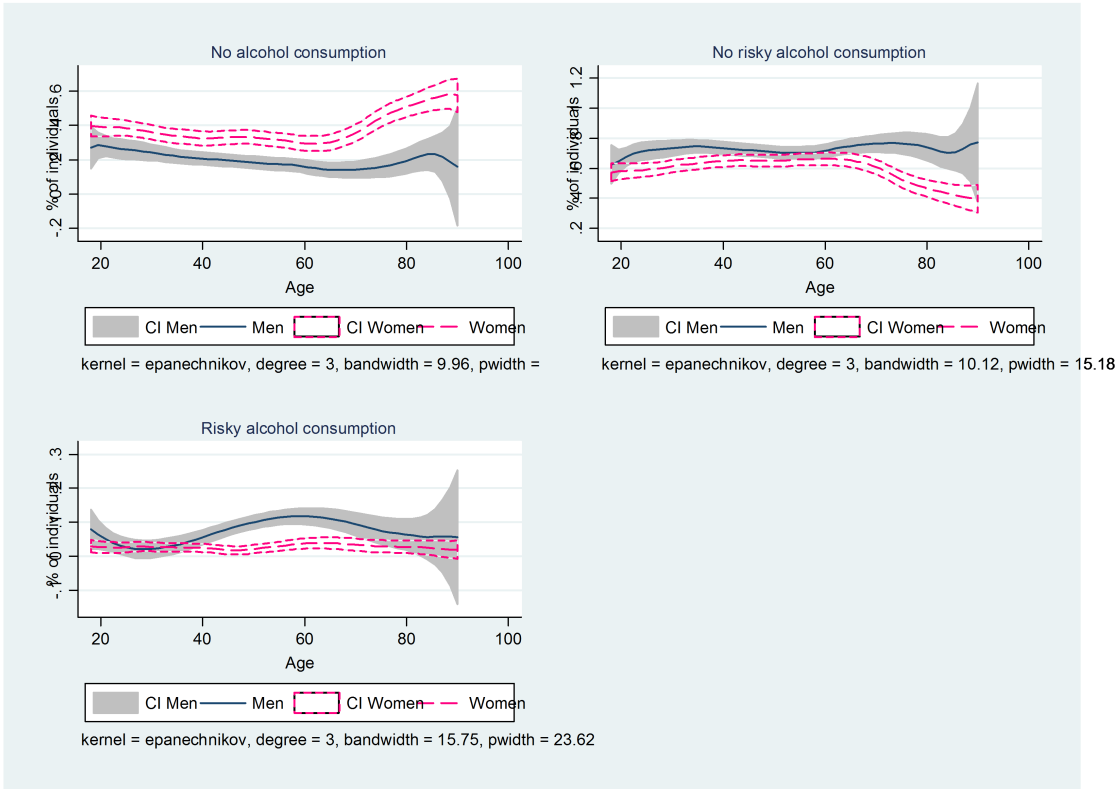

Figure A.4: BMI and obesity problems by age for men and women

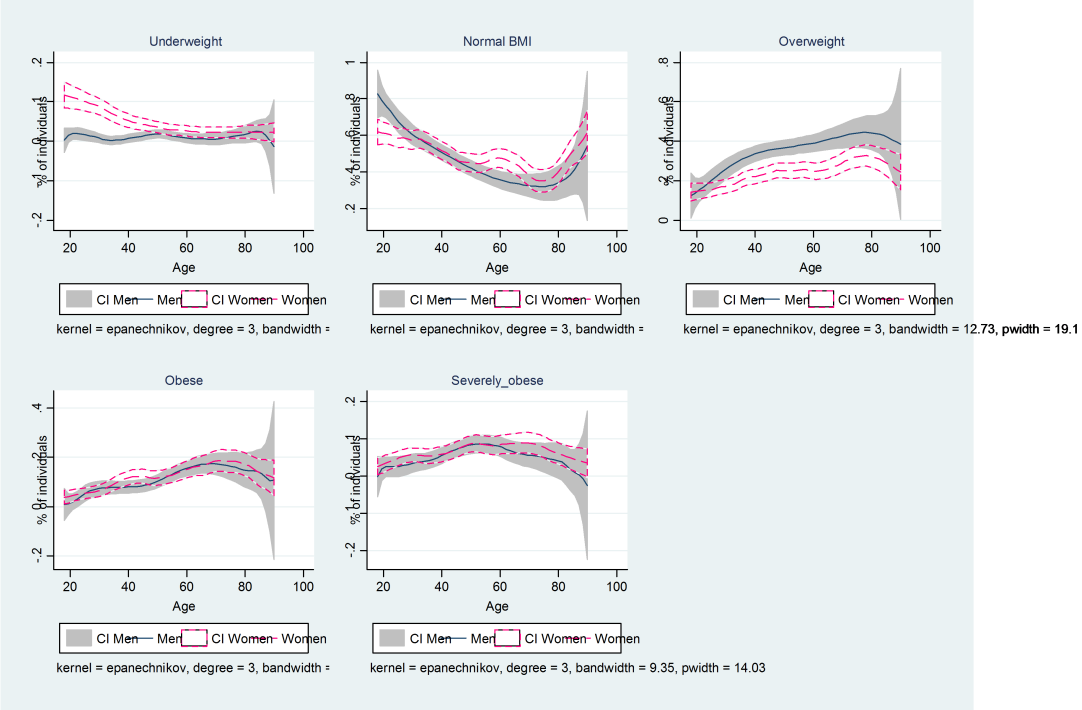

Table A.1: Prevalence of the main illnesses (women and men) and classification among the vital risk categories

	Women	Men	p-value
Illnesses of type N			
Anxiety	31.86	19.94	0.000
Lumbago	26.3	23.02	0.036
Caries	19.72	22.09	0.131
Nasopharyngitis	18.62	11.36	0.000
Migraine	17.48	7.46	0.000
Gastralgia	15	10.84	0.000
Arthrosis of the knee	14.22	8.92	0.000
Allergic rhinitis	12.66	8.05	0.000
Sinusitis	12.48	8.34	0.000
Acid Reflux	11.6	8.24	0.002
Varicose vein	8.98	3.45	0.000
Colitis	8.97	4.11	0.000
Deafness	8.23	11.02	0.006
Arthrosis of the hip	7.55	5.23	0.005
Urinary infection	7.46	1.27	0.000
Malfunction of thyroid	7.05	0.95	0.000
Eczema	6.68	4.31	0.006
Hemorrhoids	6.6	4.44	0.009
Menstrual disorders	5.96	0.00	0.000
Menopause troubles	4.93	0.00	0.000
Cataract	4.84	2.63	0.000
Psoriasis	4.2	2.91	0.052
Earache	3.28	2.95	0.639
Angina	3.18	1.2	0.000
Ulcer	2.79	2.21	0.299
Handicap	2.06	3.16	0.065
Glaucoma	1.91	0.90	0.008
Infirmity	0.98	1.25	0.485
Epilepsy	0.9	0.75	0.65
Overgrowth of the prostate	0.00	2.63	0.000
Illnesses of type AC			
Asthma	9.38	6.3	0.003
Heart rythm disorder	8.29	5.8	0.004
Cancer	2.68	1.86	0.096
Angina pectoris	1.64	2.23	0.204
Myocardial infarcts	1.53	2.87	0.005
Stroke	1.24	1.21	0.937
Illnesses of type A			
Depression	12.07	5.32	0.000
Illnesses of type C			
Hypertension	17.22	12.99	0.000
Cholesterol	13.26	13.76	0.66
Bronchitis	8.07	7.15	0.338
Diabete	6.2	7.34	0.166
Arteritis	1.28	2.09	0.048
Hepatitis	0.42	0.81	0.158
Parkinson	0.34	0.13	0.169
Alzheimer	0.21	0.04	0.096

Notes: All illnesses resulting from open declarations are also classified into the four vital risk categories. However, as they are numerous, they are not reported in the table in order to improve readability.

Table A.2: First-stage regressions, women and men

	Women	Men
AGE		
Age	-0.447***	-0.427***
	(0.154)	(0.155)
Age^2	0.004**	0.003**
	(0.002)	(0.002)
HEALTH		
Vital Risks:		
0 illness of type N	Ref.	Ref.
1-2 illnesses of type N	-5.631***	-2.629**
	(1.441)	(1.135)
$\geq$ 3 illnesses of type N	-9.942***	-6.006***
	(1.446)	(1.264)
0 illness of type AC	Ref.	Ref.
1 illness of type AC	-6.928***	-3.567***
	(1.269)	(1.309)
$\geq$ 2 illnesses of type AC	-7.313***	-5.785**
	(2.627)	(2.427)
0 illness of type A	Ref.	Ref.
$\geq$ 1 illnesses of type A	-8.576***	-10.528***
	(1.441)	(1.705)
0 illness of type C	Ref.	Ref.
1 illness of type C	-1.813	-3.749***
	(1.199)	(1.150)
$\geq$ 2 illnesses of type C	-4.982***	-8.804***
	(1.726)	(1.589)
Functional Limitations:		
Difficulties to walk: Yes	-4.458***	-6.057***
	(1.391)	(1.457)
Bed-ridden: Yes	-2.119	-1.447
	(1.559)	(1.642)
Difficulties in everyday activities: Yes	-5.630***	-5.465***
	(1.544)	(1.610)
Pain: Yes	-3.415***	-2.194*
	(1.221)	(1.120)
PARENT DEATH AND AGE OF DEATH		
Father alive	Ref.	Ref.
Father deceased - age unknown	0.889	-0.080
	(2.241)	(2.015)
Father deceased - age $<$ than the ind.	2.510*	0.894
	(1.283)	(1.212)
Father deceased - age $>$ than the ind.	0.161	-0.689
	(1.955)	(1.938)
Mother alive	Ref.	Ref.
Mother deceased - age unknown	-1.841	-0.119
	(2.756)	(2.416)
Mother deceased - age $<$ than the ind.	-0.618	-2.972**
	(1.423)	(1.338)
Mother deceased - age $>$ than the ind.	-0.205	-2.843
	(2.197)	(2.256)
LIFESTYLES		

Continued on next page

Table A.2 – continued from previous page

	Women	Men
Smoker	-2.049*	-3.343***
	(1.071)	(0.931)
Underweight	-1.114	-13.706***
	(2.116)	(4.040)
Normal weight	Ref.	Ref.
Overweight	-2.775**	-1.541
	(1.132)	(0.988)
Obese	-3.273**	-2.778*
	(1.530)	(1.554)
Severely obese	-10.396***	-8.646***
	(1.853)	(1.898)
No Alcohol	Ref.	Ref.
Alcohol - no risk	3.052***	1.171
	(0.990)	(1.117)
Alcohol - risky behaviour	-1.316	-0.733
	(2.872)	(1.933)
SOCIO-DEMOGRAPHIC		
Education:		
No diploma	-3.773**	-3.053
	(1.836)	(1.896)
Primary School certificate	-5.893***	-2.006
	(1.897)	(1.947)
GCSE	-4.125***	-0.895
	(1.383)	(1.264)
Baccalauréat	Ref.	Ref.
University (≤ 2 years)	-0.676	1.222
	(1.662)	(1.666)
University (≥ 3 years)	-2.797	1.010
	(1.704)	(1.534)
Other diploma	-30.421**	-13.124
	(13.924)	(8.445)
Income:		
Income ≤ 875 €	-4.080***	-2.507*
	(1.402)	(1.334)
Income $\in [875 - 1290]$ €	-3.251**	-0.720
	(1.294)	(1.206)
Income $\in [1290 - 1800]$ €	Ref.	Ref.
Income > 1800 €	-1.085	0.294
	(1.364)	(1.183)
Health Insurance:		
National Health Ins. only	-1.093	-2.544
	(2.199)	(1.676)
CMUC only	2.283	-5.373**
	(2.012)	(2.211)
Complementary Insurance	Ref.	Ref.
Family Situation:		
Marital life	0.837	1.363
	(1.042)	(1.039)
Single	Ref.	Ref.
At least one child	0.402	1.170
	(1.065)	(1.086)
No Child	Ref.	Ref.
Constant	102.784***	99.529***
	(3.724)	(3.555)

Continued on next page

Table A.2 – continued from previous page

	Women	Men
N	1504	1292
Fisher stat. (Weak Instruments)	21.40	17.01
Sargan stat	4.482	4.385
(p-value)	0.214	0.223
Hausman stat (SLE)	0.08	1.93
(p-value)	0.783	0.165
Hausman stat (SUL)	3.06	3.56
(p-value)	0.08	0.06

Table A.3: Three-stage least squares estimation of the three-equation model, women and men

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
AGE						
Age	-0.448***	-0.288***	0.084**	-0.422***	-0.163*	0.094**
	(0.152)	(0.075)	(0.039)	(0.153)	(0.085)	(0.042)
Age^2	0.004**	0.006***	-0.003***	0.003**	0.005***	-0.003***
	(0.002)	(0.001)	(0.000)	(0.002)	(0.001)	(0.000)
HEALTH						
SAH	-	0.095**	0.044*	-	0.048	0.040
		(0.044)	(0.023)		(0.054)	(0.027)
Vital Risks:						
0 illness of type N	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1-2 illnesses of type N	-5.615***	-0.116	1.062***	-2.609**	-0.786	0.283
	(1.422)	(0.724)	(0.379)	(1.117)	(0.626)	(0.311)
$\geq$ 3 illnesses of type N	-9.922***	-0.714	1.222***	-6.015***	-1.646**	0.571
	(1.427)	(0.870)	(0.455)	(1.244)	(0.798)	(0.396)
0 illness of type AC	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 illness of type AC	-6.931***	-1.258*	0.219	-3.563***	-1.198*	0.474
	(1.252)	(0.688)	(0.360)	(1.288)	(0.726)	(0.361)
$\geq$ 2 illnesses of type AC	-7.294***	1.425	0.202	-5.821**	-1.997	0.653
	(2.591)	(1.292)	(0.676)	(2.389)	(1.343)	(0.668)
0 illness of type A	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
$\geq$ 1 illnesses of type A	-8.575***	-1.154	0.249	-10.478***	-2.756**	0.516
	(1.421)	(0.818)	(0.428)	(1.678)	(1.084)	(0.538)
0 illness of type C	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1 illness of type C	-1.810	-0.857	0.347	-3.741***	-0.380	0.739**
	(1.183)	(0.563)	(0.294)	(1.132)	(0.654)	(0.325)
$\geq$ 2 illnesses of type C	-4.953***	-2.628***	-0.428	-8.833***	-2.628***	0.013
	(1.703)	(0.838)	(0.438)	(1.564)	(1.002)	(0.498)
Functional Limitations:						
Difficulties to walk: Yes	-4.649***	-	-	-5.603***	-	-
	(1.351)			(1.407)		
Bed-ridden: Yes	-2.444	-	-	-1.073	-	-
	(1.511)			(1.579)		
Difficulties in everyday activities: Yes	-5.317***	-	-	-6.101***	-	-
	(1.500)			(1.553)		
Pain: Yes	-3.404***	-	-	-2.198**	-	-
	(1.185)			(1.078)		
PARENT DEATH AND						

Continued on next page

Table A.3 – continued from previous page

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
AGE OF DEATH						
Father alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Father deceased - age unknown	0.853	0.335	0.505	-0.073	0.145	-0.087
	(2.211)	(1.036)	(0.542)	(1.983)	(1.070)	(0.532)
Father deceased - age $<$ than the ind.	2.503**	-0.733	0.235	0.889	-0.877	-0.372
	(1.266)	(0.607)	(0.317)	(1.193)	(0.645)	(0.321)
Father deceased - age $>$ than the ind.	0.160	0.067	0.428	-0.647	-1.308	0.055
	(1.929)	(0.905)	(0.473)	(1.908)	(1.026)	(0.510)
Mother alive	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Mother deceased - age unknown	-1.806	-4.052***	-0.244	-0.128	-3.819***	-0.651
	(2.719)	(1.274)	(0.666)	(2.379)	(1.284)	(0.638)
Mother deceased - age $<$ than the ind.	-0.602	-2.495***	-0.328	-2.945**	-1.276*	-0.318
	(1.403)	(0.658)	(0.344)	(1.317)	(0.722)	(0.359)
Mother deceased - age $>$ than the ind.	-0.169	-3.177***	-0.117	-2.833	-2.145*	-0.126
	(2.168)	(1.016)	(0.531)	(2.221)	(1.205)	(0.599)
LIFESTYLES						
Smoker	-2.033*	-1.939***	0.003	-3.347***	-2.471***	-0.271
	(1.056)	(0.507)	(0.265)	(0.917)	(0.526)	(0.262)
Underweight	-1.125	-1.325	-0.364	-13.676***	3.582	-1.074
	(2.088)	(0.981)	(0.513)	(3.977)	(2.245)	(1.116)
Normal weight	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Overweight	-2.789**	0.444	0.308	-1.548	-0.359	0.048
	(1.117)	(0.536)	(0.280)	(0.973)	(0.534)	(0.265)
Obese	-3.259**	1.745**	0.547	-2.781*	-0.173	-1.031**
	(1.509)	(0.730)	(0.382)	(1.530)	(0.848)	(0.421)
Severely obese	-10.408***	-0.004	0.574	-8.676***	-1.362	-0.767
	(1.827)	(1.002)	(0.524)	(1.868)	(1.120)	(0.557)
No Alcohol	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Alcohol - no risk	3.056***	1.110**	-0.337	1.175	1.322**	-0.025
	(0.976)	(0.482)	(0.252)	(1.100)	(0.598)	(0.297)
Alcohol - risky behaviour	-1.313	0.538	0.135	-0.747	-2.363**	0.056
	(2.834)	(1.331)	(0.696)	(1.903)	(1.027)	(0.510)
SOCIO-DEMOGRAPHIC						
Education:						
No diploma	-3.774**	-0.519	0.291	-3.120*	-1.198	-0.310
	(1.811)	(0.861)	(0.450)	(1.866)	(1.019)	(0.506)
Primary School certificate	-5.908***	-0.314	0.651	-2.029	-1.911*	-0.228
	(1.872)	(0.904)	(0.473)	(1.917)	(1.038)	(0.516)
GCSE	-4.127***	-1.147*	1.125***	-0.918	-2.809***	-0.567*
	(1.365)	(0.666)	(0.348)	(1.244)	(0.672)	(0.334)
Baccalauréat	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
University ($\leq$ 2 years)	-0.672	0.944	1.133***	1.183	-1.579*	-0.748*
	(1.639)	(0.771)	(0.403)	(1.640)	(0.889)	(0.442)
University ($\geq$ 3 years)	-2.805*	0.993	0.543	0.972	-0.408	0.093
	(1.681)	(0.800)	(0.419)	(1.510)	(0.815)	(0.405)
Other diploma	-30.500**	-3.088	1.743	-13.144	1.972	2.006
	(13.737)	(6.578)	(3.440)	(8.313)	(4.530)	(2.251)
Income:						
Income ≤ 875 €	-4.092***	-1.133*	-0.018	-2.517*	-0.850	-1.229***
	(1.383)	(0.677)	(0.354)	(1.313)	(0.725)	(0.360)
Income $\in [875 - 1290]$ €	-3.256**	-0.401	0.183	-0.740	-0.109	-0.543*
	(1.276)	(0.616)	(0.322)	(1.187)	(0.641)	(0.319)

Continued on next page

Table A.3 – continued from previous page

	Women			Men		
	(1) SAH	(2) SLE	(3) SUL	(1) SAH	(2) SLE	(3) SUL
Income $\in [1290 - 1800]$ €	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Income > 1800 €	-1.082	-0.042	-0.248	0.293	-1.188*	-0.497
	(1.346)	(0.632)	(0.331)	(1.165)	(0.629)	(0.312)
Health Insurance:						
National Health Ins. only	-1.069	-0.868	0.937*	-2.528	0.724	0.119
	(2.169)	(1.019)	(0.533)	(1.650)	(0.899)	(0.447)
CMUC only	2.333	-0.435	0.350	-5.381**	-4.435***	0.422
	(1.984)	(0.935)	(0.489)	(2.177)	(1.211)	(0.602)
Complementary Insurance	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Family Situation:						
Marital life	0.841	0.627	0.453*	1.362	0.013	-0.044
	(1.028)	(0.482)	(0.252)	(1.022)	(0.559)	(0.278)
Single	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
At least one child	0.401	-0.103	-0.191	1.170	-0.609	-0.179
	(1.050)	(0.493)	(0.258)	(1.069)	(0.580)	(0.288)
No Child	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Constant	102.789***	73.626***	8.262***	99.458***	75.561***	10.189***
	(3.674)	(4.952)	(2.589)	(3.498)	(5.669)	(2.817)
R2	0.352	0.316	0.425	0.357	0.320	0.381
St. Dev of Dependent Variable	21.04	9.61	5.48	18.45	9.69	5.04
RMSE	16.93	7.95	4.16	14.79	7.98	3.97
N		1504			1292	